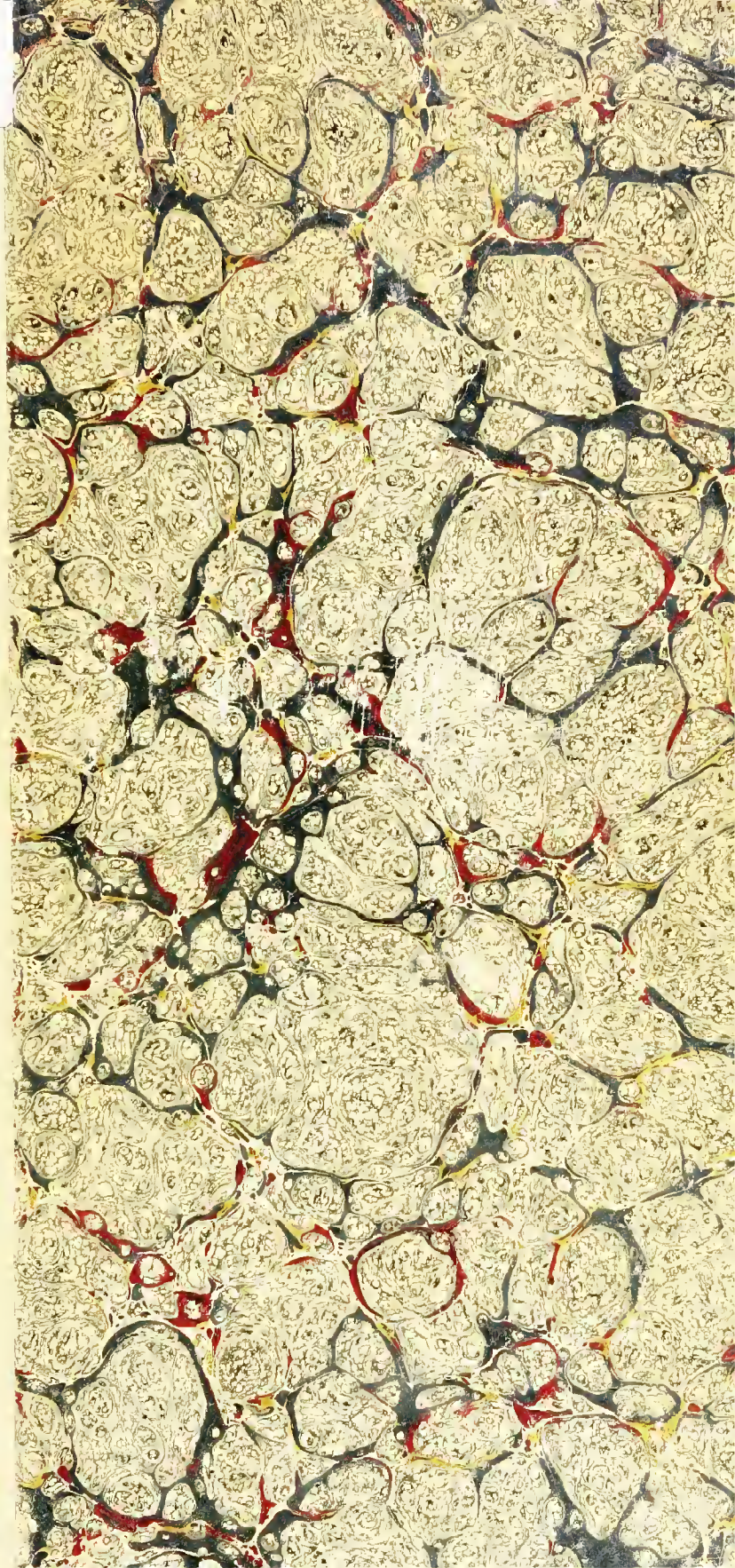


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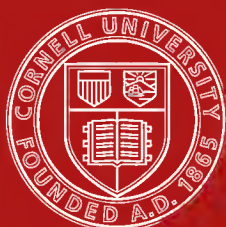
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DEPARTMENT OF AGRICULTURE AND TECHNICAL
INSTRUCTION FOR IRELAND.



SOME FEATURES

OF

AMERICAN EDUCATION,

BY

ROBERT BLAIR, M.A. (EDIN.), B.Sc. (LOND.),

*Assistant Secretary in respect of Technical Instruction,
Department of Agriculture and Technical
Instruction for Ireland.*



DUBLIN:

PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE,
BY ALEX. THOM & CO. (LIMITED), 87, 88, & 89, ABBEY-STREET

1904.

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NOTE.

In June, 1903, Mr. Alfred Mosely, c.m.g., invited the Vice-President of the Department of Agriculture and Technical Instruction for Ireland to nominate two members of a Commission of Inquiry, of which he proposed to defray the entire cost, to investigate the methods of education in parts of the United States of America, with special regard to their bearing on commercial and industrial efficiency.

The Vice-President nominated the Rev. T. A. Finlay, a member of the Board of Technical Instruction, and Mr. Robert Blair, Assistant Secretary of the Department in respect of Technical Instruction. These gentlemen visited the United States in company with some thirty representatives of British educational authorities and institutions. The Commission sailed for America on the 3rd October, and the members had all returned before Christmas, 1903. The following report, written by Mr. Blair, includes a description of some of the educational features of the United States, and his opinions on some of the American methods. The report gives much information concerning some of the leading technical institutions of the United States; and it is believed that its issue as a Departmental *Bulletin* will serve a very useful purpose. At the same time the Department accepts no responsibility for the author's opinions or conclusions.

TO THE SECRETARY, DEPARTMENT OF AGRICULTURE AND
TECHNICAL INSTRUCTION FOR IRELAND.

SIR,

I have the honour to submit a report on the visit which, on the suggestion of the Vice-President and yourself, I made to the United States of America as a member of the Mosely Education Commission.

The Mosely Commission arrived in the United States on the 10th of October. I left New York on the return voyage on November 14th. This visit to America was my first. I had thus exactly five weeks in which to acquire a knowledge of the educational system of the States, and to gather something of its spirit, keeping my own work of technical education specially in mind. Distribution of time was, therefore, a serious matter. For almost a fortnight—during the visits to New York, Washington, and Hampton—I kept in close contact with the main body of the Commission; after that, with Mr. Mosely's permission, I travelled and worked alone. I visited institutions in Chicago; Champaign, Illinois; Pittsburg; Boston, Bridgewater, and Springfield, Massachusetts; Ithaca (Cornell University); and Philadelphia. At Pittsburg, Philadelphia, and New York, I interviewed heads of large industrial concerns; and with the help of introductions from Sir Percy Sanderson—British Consul-General at New York—I was able to elicit opinions on the relation of technical education to industry and commerce from some of the ablest business men in the States. At every institution or firm I visited, the greatest kindness was extended to me: I was able to see whatever I wanted in schools, colleges, universities, and industrial firms. I had opportunities, which far exceeded my expectations, of discussing educational questions with presidents of institutions, heads of industrial, commercial, and educational establishments; and I shall long remember the generous disposition of the people who placed so much of their valuable time at my disposal.

When all were so kind, it may be somewhat invidious to mention specially some names; yet I feel bound to add that very great assistance was given to me by Mr. W. H. Maxwell, Superintendent of Schools, New York City; Mr. Thomas M. Balliet, Superintendent of Schools, Springfield, Massachusetts, and Professor Arthur A. Noyes, of Massachusetts Institute of Technology, Boston.

I do not pretend to have made anything like a full study of American education—such a study was impossible in the time. I gave, however, sufficient time to general education to enable me to appreciate the relationship and the true proportion of technical education to the organic whole. I saw much to admire, some things not to envy, and few to copy slavishly; but I saw and read and heard a good deal that cannot but be of great use.

I would like to add that this brief report is not to be understood as a criticism of American education; I considered that my business in the States was not to criticise, but to draw from American institutions as many useful lessons as possible for our own purposes.

I have to thank my colleague, Mr. J. C. Smail, who very kindly undertook to prepare the appendices, and to see them through the Press.

I am, Sir,

Your obedient Servant,

R. BLAIR.

DUBLIN,

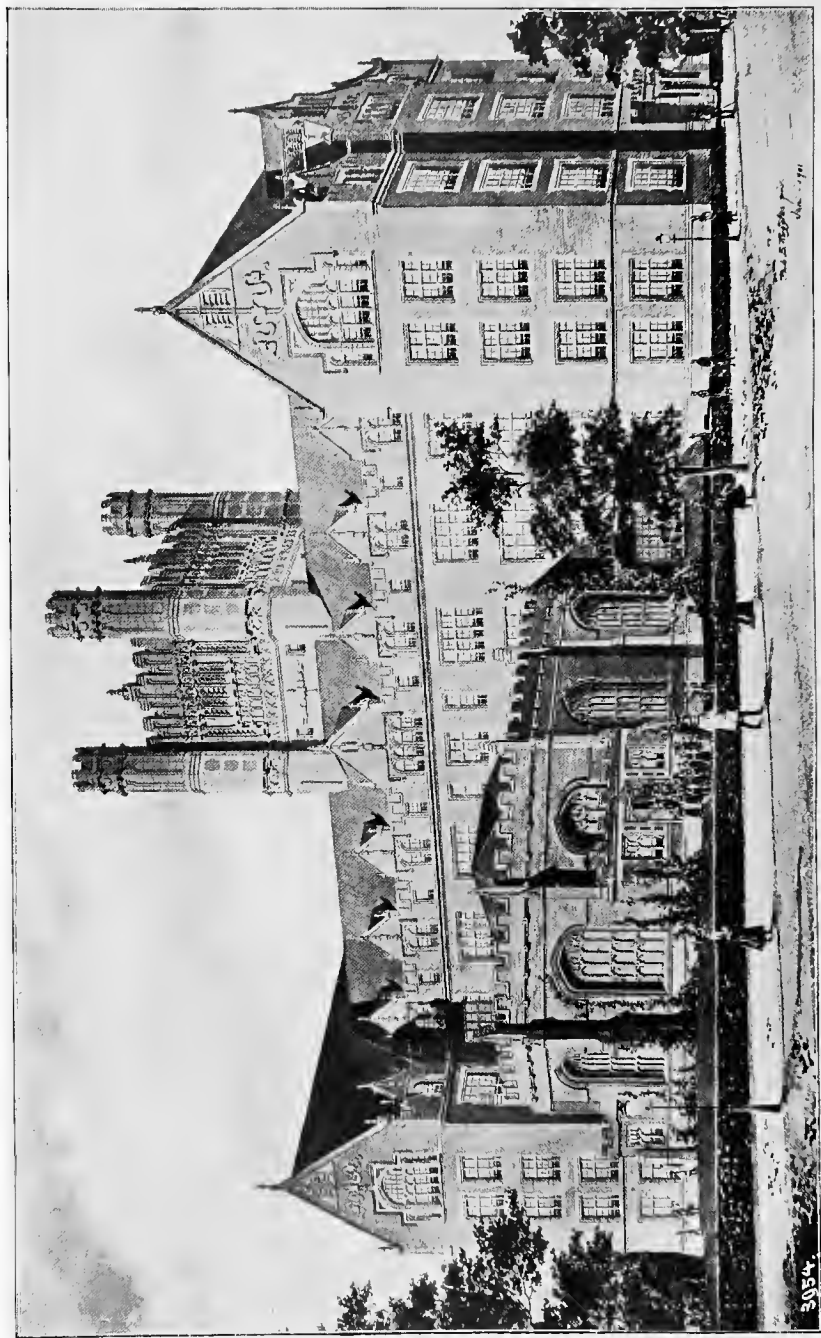
February, 1904.

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The Peter Cooper High School.—New York City.

DEPARTMENT OF AGRICULTURE AND TECHNICAL
INSTRUCTION FOR IRELAND.

SOME FEATURES OF AMERICAN EDUCATION,

BY

ROBERT BLAIR, M.A. (EDIN.), B.Sc. (LOND.),

ASSISTANT SECRETARY FOR TECHNICAL INSTRUCTION,
DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR
IRELAND.

INTRODUCTION.

As a preliminary to a statement of the results of my inquiries, it may be as well to begin by pointing out that the United States of America do not form a union of States in which, by a devolution of authority, certain powers of local government have, for convenience, been conferred by the Federal or National Government on local authorities—the States. The contrary is the case. The Federal Government possesses only those sovereign powers which have been conferred on it by the States. Of these powers control of education is not one. When the Constitution of the United States was being framed education was not a matter of public concern. No question of the powers of the Central (or Federal) Government in respect of education thus arose; and consequently none were entrusted to it. For a time, too, education was only in a few rare cases a subject of concern to individual States. But need for funds gradually led to taxation, that to oversight; and to-day the tendency is everywhere for the State to take control. The State having absolute control (subject to the Constitution) over all communities within its area, can assume the full control of education. As a rule the action of the State is not in advance of public opinion; and no more power is taken than is assented to. The amount of control assumed varies, therefore, largely in different States. The tide, however, sets strongly in favour of centralisation; the opposite of the administrative movement in England.

Education was at first a matter for families: co-operation for greater efficiency led to action by larger groupings of families; then to school districts, and gradually to township or county or city organisation. The American people realised before we

did that education was a child's birthright; that the absence of it was a danger to the common weal. As they come to fully appreciate the advantages of central stimulus and control—the gains to the poorer districts by the equalisation of benefits, the advantages of system in respect of the qualification of teachers—so will they entrust the State with more and more power.

The Federal or National Government, though it has no oversight over the school system, has not, however, neglected it. The Department of the Interior has a section—the Bureau of Education—devoted to the collection and redistribution of statistics and information (home and foreign) on every conceivable educational subject. Further, the National Government has endowed education with large grants of land and money, the aggregate reaching a total of £60,000,000 sterling—a splendid endowment, yet, though the current of educational opinion has set strongly in favour of centralisation in each State, the day is apparently far distant when, if ever, the States will entrust their educational system to the Federal Government.*

The absence of some directive control by a national (not State) bureau, seems to me a conspicuous weakness of the system: the splendid parts of their educational machine would, in my opinion, be much more efficient if, to some extent, under the guidance, stimulus, and control of a national department.

Seeing that State control is a later feature of American education, and that the origin and growth of educational institutions has been a local or district one, it might be imagined that the different physical features, the varying climatic conditions, the difference in density and in industrial character of the population in different areas, the separate historical origin sometimes of individual States, and sometimes of the great groups of States, such as those of New England, the South Atlantic States, the North-Western States, those of the Mississippi valley, or the States on the Pacific slope, might have produced, not a system with recognisable general features, but a group of systems or a miscellaneous un-coordinated collection of institutions. There is, indeed, much evidence of variety and difference in detail; but the essentials are everywhere the same; the main features bear so much resemblance as to mark out a fairly complete and symmetrical system.

* In dealing with money values, the number of dollars has always been divided by 5 to obtain the number of pounds. Such a method of conversion does not bring out comparative values; the purchasing power of money in the United States differing considerably from that in the United Kingdom. The differences vary greatly: an average may be struck by regarding the purchasing power of 5 dollars in the States as equal to 15s. in the United Kingdom.

This relatively remarkable uniformity is due, I believe, to two or three primary causes. In the first place the population has flowed from east to west, and the Americans, owing to their standard of civilisation (they wanted schools) and to their industrial activity (they had no time to solve new school problems), have been imitative in their institutions, following in education, mainly the New England models. Secondly, with the facilities for intercommunication and the constant movement of population, there have been no opportunities for the growth of marked localism; thirdly, ideals, and the opinion that ultimately leads to the shaping of the system, come from within the system—from the teachers; these speaking finally through the National Educational Association.

The leading features of American education which give it a systematic character are free elementary schools, free high schools, and, especially in the Middle West, free universities. These three sets of institutions are not separate and unrelated organisms, but co-related and inter-dependent organs; the products of one being the assimilative material of the next. There is considerable danger in attempting to generalise; but, it may be said, that these features are so common as to be almost universal. One striking exception may prove this rule; Massachusetts has no free university.

I propose to devote some remarks to the elementary schools and to the high schools, for these, in addition to being the institutions which provide the general education of the cities, form the basis of technical education.

CHAPTER I.

THE LOCAL GOVERNMENT AND SUPPORT OF THE SCHOOLS.

The local government of the schools in the New England States differs largely in character from that of the Southern States: the middle and Western States have a mixed system. The differences are due to historical causes. In the New England States the active local unit is the

Local Authorities.

"town" — a distinctively rural district. The area of the "town" frequently does not exceed a few square miles. Its inhabitants meet once a year—the old English folk-mote—and among other legislative and executive acts, choose the School Committee, the executive officers, and vote the necessary taxes. The meeting may also authorise certain executive acts. The officers are paid or unpaid, according to the size of the "town." For some or all school purposes, several towns may, and do, combine; the combination is of local seeking, not due to pressure of a State authority.

In the Southern States the county is the unit of local government. In New England the State grew out of a combination of "towns"; in the South the State divided its area into counties. In the one the State followed, in the other preceded, the local authority. The county raises its own school tax. In both "town" and county, comparative poverty of some districts, as well as lack of uniformity in tax raising, has led to inequality of provision, and, in consequence, to State subvention and control. The State assistance may take the form of a "block" grant, as in the case of assistance to the Massachusetts high schools; or of an average attendance-grant, as in Illinois.

In the middle and Western States the county is the administrative unit; but the "town" (now a "township") exists, and makes its influence felt, though less than in the New England States.

The urban unit is the city. As cities grew they went to the State Legislature and obtained the enactment of such statutes as seemed suited to immediate requirements. It must not be overlooked that a State may grant or refuse local government as it pleases. I asked the State Superintendent of New York to explain to me the relationship of New York city government of education to that of the State, and he replied:—

"The New York City Charter gives to the authorities in that city practically sole power to fix the educational requirements of its teachers and to issue licenses. The law of the State requires that every teacher must be at least eighteen years of age, and that in all cities no one shall teach in the primary or grammar school departments who is not a graduate of a high school, whose course of instruction has not been approved by this Department, and who has not thereafter graduated from a training school whose course of study has been approved by this department, and whose work is under our inspection, or who has not graduated from some institution of equal or higher rank, or who has not had at least three years' experience. In all other respects, however, the New York City authorities are entirely independent."

The education of a city is usually entrusted to a Board of Education, whose members, as a rule, are—(a) nominated and elected by wards; or (b) nominated by wards and elected on a general ticket; or (c) nominated and elected at large; or (d) appointed by the Mayor. The Board levies its own tax and elects its own Superintendent. As a rule, the State limits the tax for local authorities.

Government by these local authorities has not, I was told, been altogether satisfactory. Political partisanship, it is said, has frequently laid its hands on the schools. Local government is reported to have been better in the rural districts than in the cities; but I was informed that appoint-

**Unsatisfactory features
of
Local Government.**

ment of teachers, through political or personal preference, rather than on ground of merit, has been common everywhere. Appointment of incompetent teachers became, thoughtful Americans say, at times a scandal; and in the greater cities funds are alleged to have been misused. In some cases it is said that corruption was responsible for the appointments; in others, weakness and sympathy for the candidate, added to oversight or disregard of the highest interests of the unfortunate children. Such an undesirable state of things, if even partly true, would explain why, with such splendid machinery and funds, and freedom from the paralysing effects of tradition, the American schools are not greatly superior to any other schools in the world. The American people are, however, gradually realising this position. It may be said that they first appreciated the material features of education—buildings, equipment, &c., which they provide freely; but that they are now beginning to appreciate the spiritual features—the need of competent teachers. When the day of full realisation comes, they will see not only that the best is obtained for the money offered, but they will also offer sufficient to attract the best. The tendency is everywhere towards good organisation.* The Committee of Fifteen of the National Education Association have suggested as the city education authority a Board with legislative but not executive functions; that the administration should consist of two sections—a business section, with a chief executive officer, and an education section with a superintendent of schools, the former administering the policy of the Board in respect of property; the latter in respect of the professional work of education. They recommend that “the latter should appoint all authorised assistants and teachers from an eligible list to be constituted as provided by law. He should assign to duties and discontinue service for cause at his discretion. He should determine all matters relating to instruction. He should be charged with the responsibility of developing a professional and enthusiastic teaching force, and of making all the teaching scientific and forceful. He must perfect the organisation of his department, and make and carry out plans to accomplish this. If he cannot do this in a reason-

* See “The Chicago Educational Commission,” page 265, Volume 10, Special Reports; and also Report by the Committee of Fifteen of the National Education Association.

able time he should be superseded by one who can." The officer in the States who comes nearest to this ideal is the City Superintendent of New York. He has been appointed for six years, salary 8,000 dollars per annum, with powers approximating to this ideal of the National Education Association.

It was interesting to note that the tendency to place full executive power, weighted with responsibility, in the hands of a removable officer, is a general tendency in American institutions; and is due to the signal success of the single individuals who have controlled the great operations of the United States—the great industries, the great commercial firms, the great railways. "No talents," says Bryce,* "of the practical order can be too high for such a position as this (president of a great railway), and even the highest talents would fail to fill it properly except with a free hand. Concentration of power and an almost uncontrolled discretion are needed; and in America, whatever commercial success needs is sure to be yielded."

**Tendency to rely on
one Executive Officer.**

At present many regard the object of placing so much power in the hands of removable city superintendents as a means of escape from the pressure of political parties; many, however, look to it as due to the needs of educational success. There is also an excellent precedent: the most successful educational administrators in the States are the presidents of the leading universities. These are chosen rather as "men of affairs" than as scholars; they have much power, and an almost uncontrolled discretion. Conferring such powers on removable city superintendents will in some cases, and for a time, be for evil; as a rule it will, in my opinion, work for great good.

The Americans as a nation believe in education. Sometimes the grounds given for the belief are inadequate; the Americans believe in education because they believe in themselves and in their institutions. Thoughtful Americans, however, explain their belief on the "educate our masters" theory—that education is a requirement for the stability and security of society. On the diffusion of education, they believe, rests the preservation of the State; make the people intelligent, they say, and they will be vigilant in the exercise of their duties of citizenship. Further, many view with some apprehension the half million of immigrants annually admitted to their ports. A morning with the steerage passengers on a big west-bound liner induces a share in these apprehensions. The assimilative power of language, institutions, and ideas has to grapple with the first descendants of this motley crowd. The school is the institution which focuses this power; it is the laboratory of national unity; the womb in which these aliens are "born again." "Education," says John Dewey of Chicago University, "is the one thing in which the American people believe without reserve, and to which they are without reserve committed. . . . I believe the

Belief in Education.

* See Bryce's "Commonwealth," volume II., c. xcix., Railroads.

necessity of education is the only settled article in the shifting and confused social and moral creed of America."

Some striking evidence of the value put on higher education in the Central West, as shown by the rapid increase of students in recent years, is to be found in Appendices, p. 136.

Democracy is prudent; it believes that money spent on education is put to its highest economic use: education is insurance against dissolution.

Because of their belief in education Americans give generously, possibly lavishly, to the support of their schools. As already mentioned, the Federal Government has provided, in land grants, and money, an endowment of £60,000,000. By their lavish gifts to higher institutions—£14,000,000 in 1899—American millionaires have learnt how to build a monument to themselves in four years, and to make it reach the sky in a lifetime.

The average expenditure per annum per pupil in average attendance at the common or elementary schools is—

(a.) For site, buildings, &c., .	\$3·79	
(b.) For salaries of teachers, .	\$13·64	} = \$17·59 = £3·52
(c.) For all other purposes, .	\$3·95	
	<u>\$21·38</u>	= £3 10s. 5d.

In England the cost of the same pupil is £3 0s. 2d. in board schools, and £2 6s. 8½d. in voluntary schools; in Scotland, £2 18s. 11d.; in Ireland, £2 10s. 11d. It must not be overlooked that in the rural districts of many States (and half the school population is in the rural districts) the school year is greatly shorter than in our rural districts—average about 100 days (200 attendances in England and Scotland). Of the cost of education in the common schools—

Local taxes supply	68·5 per cent.
State " " " "	15·4 "
Income of present funds, . .	4·2 "
All other sources, ...	11·9 "

Such provision, it must be remembered, is in addition to State provision for high schools.

State aid to public schools takes various forms.

In Massachusetts local taxation for support of schools and school buildings is aided in the following four ways:—

- (1.) By an average attendance grant;
- (2.) By a "block" addition to the high school funds;
- (3.) By increase of salaries of teachers in approved cases;
- (4.) By increase in the funds providing for superintendence.

Details of these would occupy too much space; the average proportion of State aid to local taxation is shown above.

A possible explanation of the absolutely ungrudging payment of school tax may be found in the method of collection; the school tax, like other taxes, is assessed on real and personal property; and, as a rule, falls on the landlord and not directly on the occupier, who simply pays a higher rent, and does not feel the burden in the same way as a man who pays directly.

CHAPTER II.

SOME FEATURES OF ELEMENTARY AND HIGH SCHOOLS.

Attendance at the common schools is as a rule obligatory on all children from eight to fourteen years of age. The age limits, however, vary considerably ; in some cases the inferior limit is lower, and in some cases higher, with corresponding changes in the superior limit. In New York State, for example, the age limits are eight to sixteen ; in Massachusetts, seven to fourteen. The obligation of attendance is,

The Compulsory Law. in some States, only satisfied by attendance during the full session of forty weeks. In one State, however, eight weeks' attendance is sufficient ; and in twelve Western States the obligation is purged by attendance for twelve weeks.

The employment of children under certain ages, usually lower than the upper school limit, is prohibited by law in some States ; but the prohibition does not appear anywhere to be co-extensive, as regards age limits, with the law of compulsory attendance, and evils of child employment consequently exist.

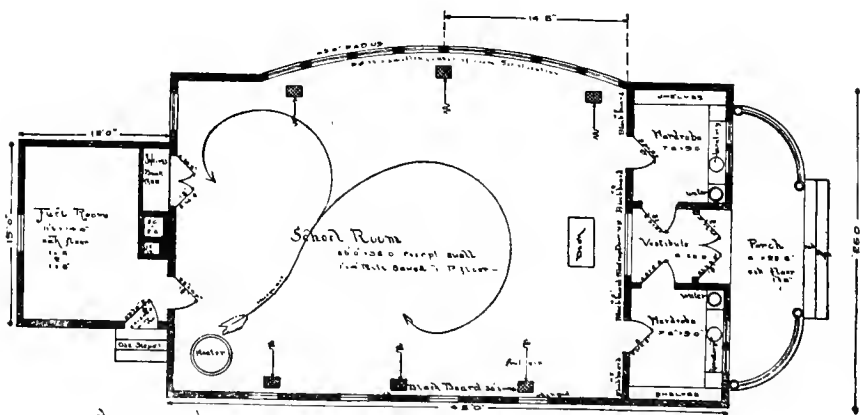
In connection with the law of compulsory attendance the length of the school year is important. In some rural districts the schools are open for but a few months in the year. The average school year for the whole of the United States is 140·5 days, or about seven months of twenty days each ; and the average ranges from ninety-three days in the South Central Division, to 175 in the North Atlantic States. Twenty-two per cent. of the whole population appeared on the school rolls at one time or another of the year 1901 ; but as it seems impossible to make any kind of comparison by enrolment, an attempt has been made to set out in the table given below a comparison of the percentages of population in daily attendance at the common schools in the United States, and in England, Scotland and Ireland. The table shows that England has the highest percentage of population in daily attendance ; but the differences between England, Scotland and the United States are inconsiderable. Ireland, however, is very far behind the three others. It should be noted that the growth of the percentage has been more regular in the United States than with us, and that before the British Education Acts of 1870-71 attendance at the American schools had been very much better than at ours ; in other words, their school system was more extensive than that of England or Scotland prior to the seventies. The compulsory law in Massachusetts dates back to colonial times ; since 1642 the law has inflicted penalties on parents for neglect of the education of their children. Americans frequently point out that where the public school



Rural School.—Illinois.



Rural School.—Illinois.



Clemantine Gault Architect Floor Plan, 1910.
110 Roofs by George T. Co.

Ground Plan of Rural School.—Illinois.

term in the United States is longest, there the average productive capacity of the citizen is greatest. The example which has given rise to this generalisation is that of the State of Massachusetts. The average duration of school life per inhabitant, taking the United States as a whole, was 4·3 years in 1897; in Massachusetts alone it was seven years, the proportions being forty-three to seventy. It is pointed out that the relation between the productive capacity of each individual in Massachusetts to that of each individual in the whole of the United States is sixty-six to thirty-seven.

SCHOOL STATISTICS.*

Percentage of Population in Daily Attendance at Common or Public Elementary Schools.

Years.	U. S. A.	England.	Ireland.	Scotland.
1869-70, ...	10·6	5·2	6·6	6·3†
1879-80, ...	12·3	10·8	8·8	11·0
1889-90, ...	13·0	13·1	10·4	12·5
1896-97, ...	14·1	14·6	11·5	14·3
1897-98, ...	14·2	14·6	11·5	14·5
1898-99, ...	13·9	14·7	11·4	14·5
1899-1900, ...	14·1	14·6	10·7	14·5
1900-1901, ...	13·8	14·7	10·8	14·2
1901-1902, ...	14·0	—	—	14·3

† For the year 1872.

The remote rural school has usually and in all countries been a pitiful thing. Salaries have not been attractive; the conditions of isolation have been benumbing for all but the most active minds; the teacher became intellectually dead; his daily task the merest routine. Funds have been insufficient to maintain decent, let alone satisfactory, premises; and these have often been in a cheerless, dirty and ill-ventilated condition.

The Rural School.

Environment as a factor in education not being understood, the schoolhouse, as in itself a teacher, was overlooked. Classification of pupils was impracticable; each child pursued a separate course of study. The absence of the stimulus of healthy rivalry and encouragement from contact with equals was a great loss. Bad roads and bad weather made attendance irregular; and first, owing to the kind of teacher possible, and next, owing to the work thrown on this teacher of bringing children of different grades up to a moderate standard of attainment, no instruction in special subjects, such as drawing, elementary science, and manual work, has been possible except in rare instances. Such features of rural schools have been as true of the States as at home, if not truer. Americans are, however, beginning to realise that soap, fresh water, paint, a picture

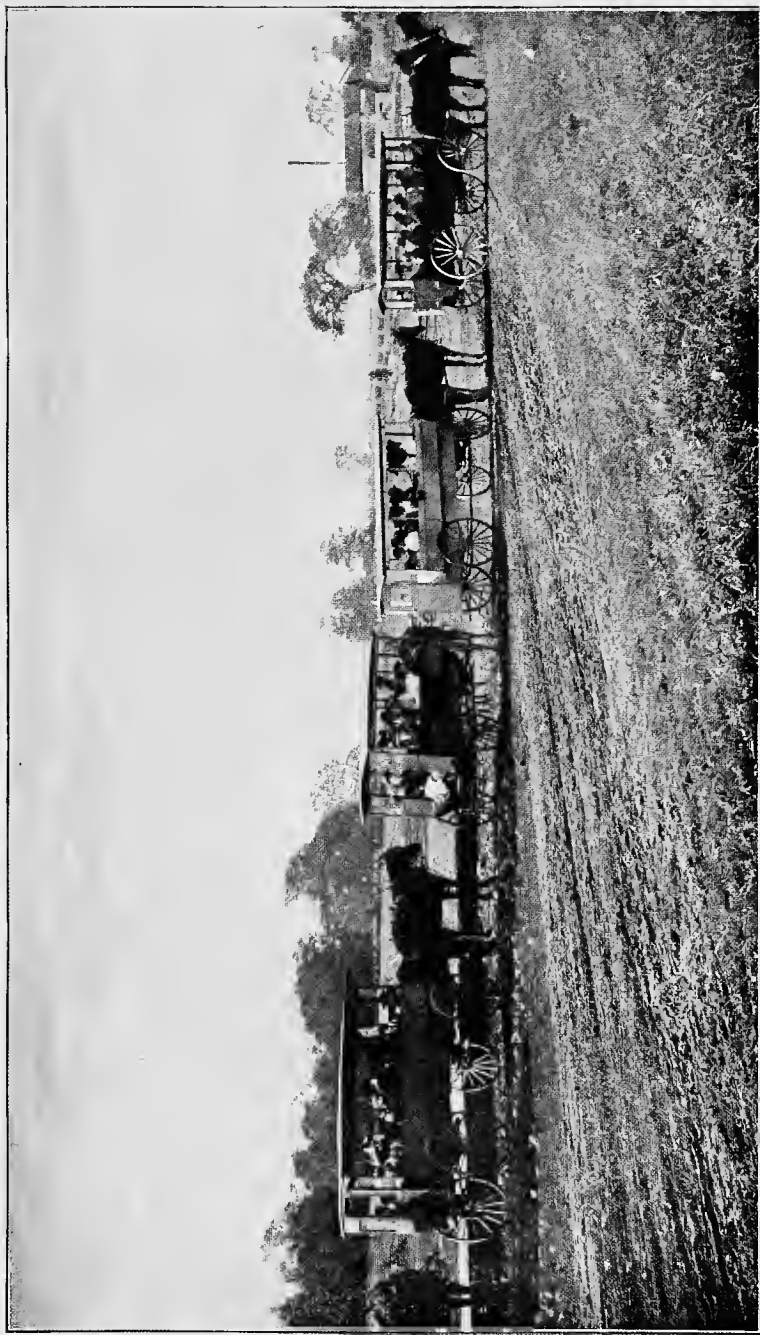
* These figures refer to public or State-aided schools. Reliable information of a similar character for private schools is not available. So far as can be estimated, the inclusion of private school statistics would not perceptibly modify the ratio of the percentages.

or two, flowers, shrubs, trees, &c., are more needed additions to the rural elementary school than Latin or mathematics. In the State of Illinois there are 12,809 schools; of these the superintendents report 1,278 "unsanitary or otherwise unsuitable," and only 1,794 as "perfectly comfortable." The cheerless character of the rural schools in some of the States have become almost proverbial. "Show me," said an observant commercial traveller, "your schoolhouse, and I will 'size up' your village." Such poor provision of elementary education for rural children has been partly the cause of the social movement developed by town allurements. The town offers superior attractions in education, as in other things; and yet the possibilities of sound educational work are greater in the rural than in the urban districts. The education of children is becoming as serious a question to parents as the feeding or clothing of them; and the problem of education for their children, to parents in rural districts, is so serious that it often acts as a very important element in determining the movement to a town.

In Chapter I. it was pointed out that the early schools were the organised efforts of few families; and the school district, that is, the local governmental area for a single school, has not yet disappeared. In Massachusetts, however, as far back as 1870 a movement in favour of consolidation began. This movement has now spread to several States, and it will no doubt do much to revolutionise the rural school system. The

**Conveyance to School
in vans.**

plan involves the closing of district schools, and the conveyance of children in vans to central schools. It is claimed that experience has demonstrated the following advantages of this system; the employment of two or three or more teachers, and in consequence the possibility of securing among them qualification to teach all the subjects of an elementary curriculum; classification of pupils and the healthy stimulus of rivalry among approximate equals; better buildings; better attendances; better equipment; better health; and all these at less cost. The disadvantages appear to be—the danger to health and morals, and general dislike to sending young children far from home. These have been met by engaging comfortable conveyances specially fitted up for school purposes, and employing none but respectable and trusted drivers—conveyance and driver being subject to most careful supervision. Where practicable, a farmer living at the extreme end of a district is employed to convey the children to school; a farmer's wife often drives the conveyance. The driver starts from near the remote end of the district, and drives down the principal thoroughfare, taking up the children at their own doors or at the cross roads. Suitable clothing has somehow or other been found. The health of the children has not suffered; in fact, greater interest in school life has led to close supervision of the mode of conveyance, to control of the little ones during the noon-day hour; and nothing but the serious obstacle of the bad condition of the American roads stands in the way of a



Going Home from School.—Illinois.

wide extension of this movement. While many of the rural school buildings are ill kept, ill ventilated, and improperly warmed, and without any colour or tasteful decoration in some States, in others the school superintendents have of recent years brought about very considerable changes. Circulars have been issued on school-room decoration, and lectures given to gatherings of teachers dealing in a direct and simple way with the tinting of walls and ceilings, the selection and hanging of pictures, and the whole matter of interior arrangement. In the State of New York, and possibly in other States, prizes of money, of United States flags, and of sets of historical engravings, have been offered for the best-kept school grounds.

City buildings, on the contrary, are, as a rule, distinctly good, and the equipment varies from sufficient to lavish. The planning of rooms, the architectural features of the structure, and the character of the work of the building, are at least as good as the average elementary school buildings in London, Leeds, Edinburgh, or Glasgow. There are no science laboratories; manual instruction rooms are not so frequent as in Great Britain; and there are no swimming baths, though some have shower baths. The city schools have followed the same general type as the British. Size of organisation, due to costly sites, may, however, prove too cheap in the end: the organisation has to be detailed too much, and the child is frequently seen with the unsympathetic eye of a machine.

As the making of citizens is the main object of the school system of the United States, an endeavour is made to create and foster a sentiment of patriotism by means unemployed on this side. Many of the elementary schools include what is known as the "flag incident" in the opening exercises. The "Stars and Stripes" everywhere flies over school buildings; as a rule it is found in individual class-rooms; and in the morning the children, with right hand outstretched towards the flag, fervently pledge themselves in the following words:—

Saluting the Flag.

"I pledge allegiance to my flag and to the Republic for which it stands—one nation indivisible, with liberty and justice for all."

In a school in which 50 per cent. of the children were Hebrews the declaration was enthusiastically made. In another school, wholly consisting of negroes, the declaration was more a piece of formal routine. Such "incidents," unless properly safeguarded, may develop bumptiousness, combativeness, and not patriotism; but in estimating its value we must endeavour to appreciate the task of making American citizens out of mixed nationalities. "Saluting the flag"—the symbol of nationality—if treated with due seriousness, and kept within proper limits, may be most helpful in welding the varied elements into one homogeneous whole.

The Board of Health of New York (and of one or two of the other great cities) has established a system of medical inspection. Since this work is undertaken by the Board of

Health and not by the Board of Education, it will be readily understood that the grounds for such action are not so much

educational as prevention of contagion. Seventy physicians, in addition to a corps of school nurses, are employed by the New York City Board of Health. The duties of medical inspection include a weekly routine inspection of the children in every school, public or private. On the occasion of his visit to a school, the pupils of each class walk past the inspector with eyelids pulled down and throat and tongue exposed. Any child suspected of having measles, scarlet fever, whooping cough, chicken pox, diphtheria, or mumps, or of having any acute catarrhal affection of the eye, nose, or throat, is told to stand aside; and a further careful examination is carried on in a room assigned to the inspector for this purpose. If exclusion of the child from school is decided on, a properly filled-in exclusion card is sealed in an envelope and the child sent home, the exclusion being notified to the principal of the school. In cases of pediculosis, trachoma, acute conjunctivitis, scabies, ring worm, impetigo, favus, molluscum contagiosum, the name of the child is entered on a class index card and the date filled in on which the child was "ordered under treatment." In the cases just mentioned the children are given forty-eight hours to get under treatment. Whenever they are under treatment within this time the card is checked up with the date "under treatment," and the child is allowed to return to the class. If any children are not under treatment within forty-eight hours they are excluded forthwith and checked up under "excluded." When the child returns for readmission he is seen by the inspector during his usual morning inspection and admitted if "under treatment." In addition to the weekly routine inspection, the inspector pays a visit each morning to the schools on his list; he examines each child that has been isolated by the teacher as a possible source of contagion; also those who have returned after absence from school for a few days for no known reason, and all "excluded children"; and he must exclude from school attendance anyone showing symptoms of an infectious or contagious disease.

Children afflicted with pediculosis, contagious eye or skin disease, or pulmonary tuberculosis, may be allowed to return to their class temporarily; exclusion cards are made out in the usual way and handed to the principal, who causes the children to be excluded at the next occurring recess. Cases of measles, scarlet fever, or small-pox are reported to the central office by telephone; throat inflammation or nasal discharge is cultured, and a duplicate culture slip is forwarded to the central office.

I spent some time inquiring into the results of this work in the office of the Board of Health, New York; but I learned that there was not sufficient accumulated experience to prove



The Assembly Hall . . . abundantly lighted.—Springfield Classical High School.



The Library.—Springfield Classical High School.

all that was claimed for the system. Its merits are obviously great; there are certain minor demerits, however, which time and experience may enable the medical staff to overcome. As a rule, the children in city schools were clean and tidy looking; in one school, where 50 per cent. were the children of Polish or Russian Jews, the little boys had nothing but trousers and shirts on; their hair and their coloured shirts appeared to be quite clean and tidy. It is possible that the medical inspection has emphasised what is already a good feature of the schools—the exceedingly clean and tidy appearance of pupils, younger and older.

The library is a greater educational institution in America than with us; and high school libraries and elementary school libraries are looked upon as an essential part of the school apparatus. It is held that a system which gives the power to read must safeguard that power by directing the reading and cultivating a taste for good literature.

School Libraries. and so school libraries are common; and how to use them, a part of the school instruction. In schools which make good use of their libraries, the school time-table is so arranged that an hour's preparatory work precedes a lesson on such subjects as history and geography; and this preparatory hour is spent in reading the subject up in the school library. To make the best use of the school library the books that would be most frequently called for are provided in sufficient numbers. The librarian employs the usual card-catalogue, and occasionally gives the pupils a demonstration on how to use the library. In the school library at Chicago University High School, I found that the librarian had a subject-catalogue, as well as a card-catalogue; a pupil desiring to read up a subject turns to the subject-catalogue and finds the authors named and the pages to be read indicated. A subject-catalogue of this character is only possible where the school staff heartily co-operate with the librarian, and where the librarian herself is skilled and experienced in cataloguing, and is a lover rather than a carrier of books. In higher institutions departmental libraries are common; and the Dewey system of classification or some modification of it is usually adopted.

Where the limits of compulsory attendance are from six to fourteen years of age the school classification involves eight grades; the work done by these grades varies from local authority to local authority; and for this reason it is considered best to give in some detail the proposals of the National Education Association.

Reading : Eight years, with daily lessons.

Penmanship : Six years, ten lessons per week for first two years, five for third and fourth, and three for fifth and sixth.

Spelling lists : Fourth, fifth and sixth years, four lessons per week.

Grammar : Oral, with composition or dictation, first to middle of fifth year, text-book from middle of fifth year to close of seventh year ; five lessons per week. (Composition writing should be included under this head ; but the written examinations on the several branches should be counted under the head of composition work.)

Latin or French or German : Eighth year, five lessons per week.

Arithmetic : Oral first and second year, text-book third to sixth year ; five lessons per week.

Algebra : Seventh and eighth year, five lessons per week.

Geography : Oral lessons second year to middle of third year, text-book from middle of third year ; five lessons weekly to seventh year, and three lessons to close of eighth.

Natural Science and hygiene : Sixty minutes per week, eight years.

History of United States : Five hours per week seventh year, and first half of eighth year.

Constitution of United States : Third quarter in the eighth year.

General History and Biography : Oral lessons, sixty minutes a week, eight years.

Physical culture : Sixty minutes a week, eight years.

Vocal music : Sixty minutes a week, eight years.

Drawing : Sixty minutes a week, eight years.

Manual training, sewing, and cooking : One-half day each week in seventh and eighth years.

The Committee recommended lessons of fifteen minutes in length in the first and second years, of twenty minutes length in the third and fourth, of twenty-five minutes in the fifth and sixth, and of thirty minutes in the seventh and eighth years. The programme given above requires in the first and second years twenty lessons of fifteen minutes each ; possibly seven other exercises, occupying an average of twelve minutes a piece each day, the total amount of time occupied in the continuous attention to the recitation of class exercises being twelve hours, or an average of one hour and twenty-four minutes a day. In the seventh and eighth grades the number of lessons requires nineteen hours per week, or three and three-quarter hours per day.

It is not easily understood why the Association should require but thirty minutes lessons from children from twelve to fourteen years of age. One can only suspect that the American child cannot concentrate his attention for a longer period. In

New York the elementary school lessons do not exceed forty minutes duration ; the high school lessons do not exceed fifty minutes duration ; and the teachers complain of the inability to concentrate attention on the part of their pupils. It is difficult to apply experience gathered at home to American school conditions. It would appear to me that in this respect

a longer period for such subjects as arithmetic and algebra might counteract the apparent inability to concentrate or to be intensive in study for more than a brief period. Concentration of thought is rarely anywhere given its importance in elementary schools; work is too frequently interrupted by small distractions, and the machine-like prompt response required to bell-ringing and other means of "discipline."

The subject-matter of studies would form suitable material for an entire report; but the limitations of space require that they must be dealt with but briefly here. English is, on the whole, well taught—better taught, I think, than in our schools; in all studies the use of good English is aimed at; and the National Education Association have insisted that use of bad English, caused by or significant of confusion of thought is, as far as possible, to be corrected by securing the elucidation of the thought. The child's best efforts in speech are to be required in all recitations, oral or written; but solecisms are for the most part to be corrected in the regular language lessons. The

study of grammar is subordinate and
Subjects of Study. auxiliary to the study of literature. I sub-

mitted some class exercises in composition which I collected in New York schools, to Mr. William Crocket, headmaster lately of Lothian-road, now of Sciennes Public School, Edinburgh, and he was kind enough to have the exercises carried out in Lothian-road and Abbey-hill Public Schools by children of the same age and under the same conditions as the exercises were carried out in New York. Such a means of comparison is not conclusive, but it has some value. Mr. Crocket's remarks on the two sets of papers, which I completely endorse, are :—

"Our children have not had such exercises before (the composition theme dictated to the class). While the American pupils would no doubt be familiar with this form of exercise, our pupils have had oral training and the writing out of a story after it had been twice read to them. I think after a little practice the American exercise would be easier than either the story so much in vogue with us, or the picture essay. Comparing the two sets of exercises, I think the writing and spelling of ours is distinctly superior, and the sentence-making and amount of matter, on the whole, as good. I like the way the Americans paragraph, and their style is perhaps freer and more natural."

Inferiority of New York spelling is obvious; but a simple explanation may be found in the mixed nationalities and foreign-born children attending the public schools.

As for drawing, American work is governed more than ours by attempts to make artistic impressionist sketches, which in the hands of competent teachers can be made of much use. As a rule, British schools look for more exact observation and delineation. In this connection I may mention that I was much struck by the capacity of ordinary class teachers to draw freely on the blackboards, which everywhere form a special feature in the class-room.

There do not appear to be any laboratories in elementary schools, and consequently no practical teaching of simple

physics and chemistry under laboratory conditions, as we understand it. The science teaching in the elementary schools is more of the nature of object lessons. This kind of work is superior in method of treatment and in character of the illustrations to object lessons as understood with us; but unfortunately, it is not Nature study (which the Americans call it)

Nature-study. in our acceptance of that term. I have always held that Nature study should be largely an outdoor exercise. The Americans, in their elementary schools, confine the subject too much to class-room instruction; and in the high schools they make it a subject of formal study, like physics and chemistry. The Nature study movement has led to improvement in the teaching of geography, in the teaching of physiography, and generally to improvement in the teaching of natural science; but the study is almost everywhere too formal and didactic.

In New York City, classes in the kindergarten (what we call infant) departments, are limited to forty pupils; in the higher grades of the elementary schools classes are limited to fifty pupils per teacher.

High Schools—Number of Pupils. More than 22 per cent. of the total population of the United States was in school for some portion of the year 1901. It has already been shown, however, that only 14 per cent. are in average daily attendance at the public elementary schools. Of the entire school enrolment 4.5 per cent., or 736,000 pupils, are in high or secondary schools, and, in addition, 238,837 students were enrolled in institutions of higher instruction. Similar proportions would require 40,000 pupils in secondary schools (fourteen to eighteen years of age) in Scotland and in Ireland; in Massachusetts, a state of about the same population as Wales, there are 40,000 pupils in high schools. The full number, 736,000 pupils, represents the enrolment of the high schools; and of course these pupils do not all remain for a full four years. The number of graduates, that is, those who had completed a full course (three years in some cases) in 1901 was 65,696, equal to, say, 3,500 Scotch pupils, who had secured the leaving certificate of the Scotch Education Department, or to 3,500 pupils in Ireland who had passed the middle and senior grades of the Intermediate Education Board. I find that in Scotland 3,505 pupils had received the leaving certificate in mathematics in the year 1902; and in Ireland, 1,419 pupils in the same year passed the middle or senior grades of the Intermediate Education Board. The growth of high school education in the United States has in recent years been enormous. The first high school was established in Boston as far back as the year 1634; but in 1860 the number of high schools in the United States was only 40; in the year 1870 they had reached 160;

and in 1880 there were in operation nearly 800 high schools. The number reached 2,526 in 1890; in 1900 the number had increased to 6,005; and in 1901 the total was 6,318. These numbers include public high schools only; the number of private high schools had increased from 1,632 in 1889-90, to 2,180 in 1894-95. Since then the number had decreased to 1,892 in 1900-01. There has been a correspondingly large increase in the number of the students in the public high schools: there were 202,963 students on the roll in 1889-90, and 541,730 in 1900-01, the pupils in private high schools increasing the number to 297,894 and 649,951 respectively. In general, the public high schools are free. Of the 6,318 schools 5,211 reported, in 1901, libraries aggregating 3,500,000 volumes; 4,923 had grounds, buildings, and scientific apparatus, &c., valued at £20,000,000. Tuition fees to the extent of £102,000 were received by 1,611 schools; the remainder of the funds for the support of all public high schools being obtained from public appropriations of State or of municipality. It has already been said that there are 40,000 pupils attending the high schools of Massachusetts; this is double the number of fifteen years ago, and means that 25 to 30 per cent. of the whole school children take advantage of the high school. In these high schools the average number of pupils per teacher is twenty-five.

The gain in totals is astonishing, and is, no doubt, due to the growing efficiency of the school and to the increase in the number of citizens interested in having their children well taught. This interest is productive, as may be inferred, not only from the generous patronage of high schools, but from the

Cost of High Schools. numerous, commodious, elaborate, and beautiful buildings which are chiefly provided for high school purposes. The

Morris High School, in New York city, cost:—

	£
Site, ...	26,430
Structure, ...	94,000
Heating and ventilating apparatus, .	10,000
Sanitary work, ...	7,100
Electric installation, ...	5,778
Furniture, &c., ...	4,310
Fire alarms, ...	135
Telephone, ...	450

Total, ... £148,203

The New York City High School of Commerce cost £118,800 for site, buildings, and equipment. There are already 20,000 pupils in New York high schools; and several new schools, similar in character and cost to those named above, are in course of construction.

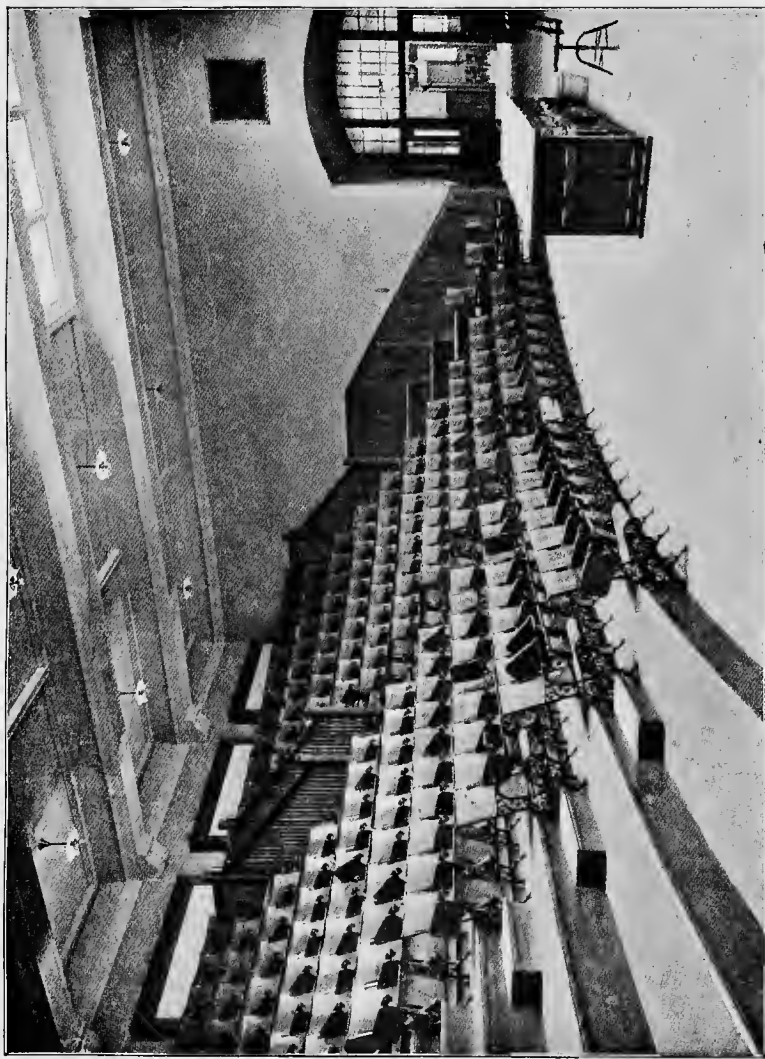
The law in Massachusetts requires every town with more than 500 families to maintain a high school, a policy substantially the same since 1826. No town with less than 500

families is required to maintain a high school; but assistance is given to every town with a less number of families to provide its own high school, or to send its children to the high schools of other towns.

High schools are connected with the elementary schools on one hand, and with the universities on the other, by means of the elementary school certificate and the high school certificate. Universities, as a rule, admit students by examination or by the certificate of some accredited high school. The system of examination is well known to us, and need not be mentioned. The system of accredited high schools is interesting, and deserves some notice. The facts which are given below refer to the accredited schools of the university of Illinois.

High schools are inspected for credit on application from the principal or superintendent. On receipt of an application, a form is sent to the applicant, and if it appears from the returns made on this form that the school is probably worthy of a place on the accredited list, an inspection will follow. The inspector may be, as in the case of the university of Illinois, an officer specially employed for that purpose, or he may be a member of the university staff, who visits the school and reports on the subjects in which the school is to be accredited, the number of credits to be given for each, and the period for which the credit assigned shall hold good. His report is considered by the council of administration, and if approved a general credit certificate, accompanied by a card giving in detail the credits allowed, is sent to the school accredited.

Credit is assigned to a high school for each subject separately, so that either the whole of the work or any part of it may be accepted. The credit certificates issued are of two kinds; one shows that the school is fully accredited, and that its graduates (that is, those who have satisfactorily completed the course) who fulfil the requirements specified, may enter into the universities without examination. The other specifies the particular subjects for which the school is accredited. From schools of the second class, graduates can, without examination, be admitted to the university in accredited subjects only. The student proceeding from a high school to a university is entitled to a certificate from the principal of his high school, giving the data on which the credits may be calculated. Accredited high schools are visited by the university officer at least once in three years, and oftener if necessary. A high school credit is based upon the work represented by sixty lessons of not less than forty minutes each, in other words, of forty hours. Two hours laboratory work are considered an equivalent to one hour recitation. On this basis three credits would be given for a subject requiring five class exercises a week during a school year of not less than thirty-six weeks; in other



The Lecture Hall.—Springfield Classical High School.



The Lunch Room or Cafe.—Springfield Classical High School.

words, one credit is measured by every forty hours recitation or its equivalent.

LESSONS OF FORTY MINUTES EACH.

Subjects.	Minimum Time.	Maximum Time.	Minimum Credit.	Maximum Credit.
	Weeks.	Weeks.		
Algebra, ...	54	60	5	5
Plane Geometry, ...	36	36	3	3
Solid and Spherical Geometry, ...	12	18	1	1
English Composition, ...	36	54	3	3
Literature and Classics, ...	72	90	6	6
Latin, ...	36	144	3	12
German, ...	36	144	3	12
French, ...	36	108	3	9
Greek, ...	36	90	3	7
General History, ...	36	36	3	3
English and U. S. History, ...	36	36	3	3
Greek and Roman History, ...	36	36	3	3
Civics, ...	12	36	1	3
Physics, ...	36	36	3	3
Chemistry, ...	24	36	2	3
Botany, ...	18	36	1½	3
Zoology, ...	18	36	1½	3
Physiology, ...	12	36	1	3
Astronomy, ...	12	18	1	1½
Physiography, ...	18	36	1½	3
Geology, ...	18	36	1½	3
Drawing, ...	12	36	1	3

Nothing less than the equivalent of the minimum specified in this table are accepted.

Forty credits are required for admission to any college of the university. Of these, the following are prescribed for all the colleges :—

Subjects.	Weeks.	Credits.
Algebra, ...	54	5
Plane Geometry, ...	36	3
English Composition, ...	36	3
English Literature, ...	72	6
Total, ...	—	17

In addition to the above seventeen credits the pupil must select, from the subjects given in the table

Prescribed Subjects. above, twenty-three additional credits.

This selection should be guided by the following regulations :—

1. For the colleges of science, engineering, and agriculture six of the twenty-three electives must be in science. Engineering students must also offer one credit in solid and spherical geometry.

2. In the college of literature and arts, three of the twenty-three credits must be from history and nine from foreign language study, at least six of which are from one language. For university courses in Latin nine credits in Latin are required.

3. For the college of law three credits in English and American history are required.

The system of accrediting has led to a close connection between the universities and the high schools; a State university being fed by the accredited high schools of that State. Some of the leading universities have, however, accredited schools in all the States. The system has considerable advantages, but it has one clear disadvantage: that the universities have gradually laid down a system of regulations for their accredited schools. Regulations is perhaps the wrong word; suggestions would be more appropriate; but the university has been in the position of power, and the suggestions

Results of Accrediting. have in reality been requirements. Those who object to the conditions of accrediting declared that literary, linguistic, and mathematical studies would be, as on the whole they are found to be, in good condition; but that they would bulk too largely in the programme. This has been the case, and the high schools have for a long time been ground between the upper mill stone of the university with classical ideals and the nether mill stone of the kindergarten ideals demanding a broader curriculum, the supremacy of self-activity, the symmetrical development of all the powers, and the necessity of following the order of nature and not the order of human convention. Many principals of schools glory in the fact that their schools are on the accredited list of a leading university. Many educationists declare that the manual training high schools are due as much to the undue pressure of the universities as to the ideals which have been evolved from an industrial system.

The rapid multiplication of high schools and the great increase in the number of pupils attending them—from 367,000 in 1889-90 to 736,000 in 1900-01—are educational phenomena which, since they are not due to the propagandist literature, the allurements of attendance grants, or the pressure of a central department, must be attributed to the causation of far-reaching social forces, such as increased wealth and consequent improvement in the conditions of life, and belief in the social and economic value of education. But it must not be overlooked that this great demand is co-extensive with, if not due in great part to, the provision of better buildings, the improvement of teachers' qualifications, and the widening of the curriculum—in other words, adequate supply and improvement in its quality has led to greater acceptance—an increase in the demand.

“Classical education,” said Dean Farrar, “neglects all the powers of some minds and some of the powers of all minds,” a saying which explained what every observant school-master has noticed—the restlessness of pupils of fourteen, fifteen, and sixteen, who had failed in the usual literary, linguistic, and mathematical studies, and who wanted to leave school and “do something.” The traditional type of education did not satisfy their minds. The introduction of laboratories and workshops has done much to meet this great need—the need of satisfying the creative as well as the acquisitive side of the human mind. As the type of institution known as the manual training high school represents, in the course preparatory to institutes or colleges of science and technology, and for industries and commerce, the form of curriculum most removed from the classical, it deserves more than passing notice. A brief summary is given below of the time-tables of:—

1. The Manual Training High School, Washington, D.C. ;
2. The Manual Training High School, Brookline, Massachusetts ; and
3. The Manual Training High School, New York City.

The figures opposite the subjects of study represent the numbers of periods per week of fifty minutes each. The New York and Washington Manual Training High Schools are independent educational units ; the Brookline institution is rather a course in, or department of, the Brookline (academic) High School. Like almost every good educational institution in the States, the manual training high school originated in Massachusetts. The movement was initiated by M. Victor Della Vos, of the Imperial Technical High School, Moscow, who in 1876 explained at a conference in Philadelphia his system of providing laboratory and shop instruction in mechanic arts—instruction in principles, retaining sufficient trade details to illustrate the principle—to his students of civil and mechanical engineering. Professor Runkle, of the Massachusetts Institute of Technology, immediately applied the methods of Della Vos to the teaching of mechanic arts at the “Boston Tec.” ; and in 1878 Professor Woodward adopted a similar course in regard to the engineering students of Washington University, St. Louis. Both institutions opened their courses to high school pupils for the purposes of demonstrating the general value of such a curriculum. After a time the “Boston Tec.” discontinued its high school section, high school work being considered outside their charter, and they confined their efforts to technological students, thus leading the way in engineering laboratories and workshops. On the other hand, the St. Louis High School section was placed on an independent footing, and it has gradually

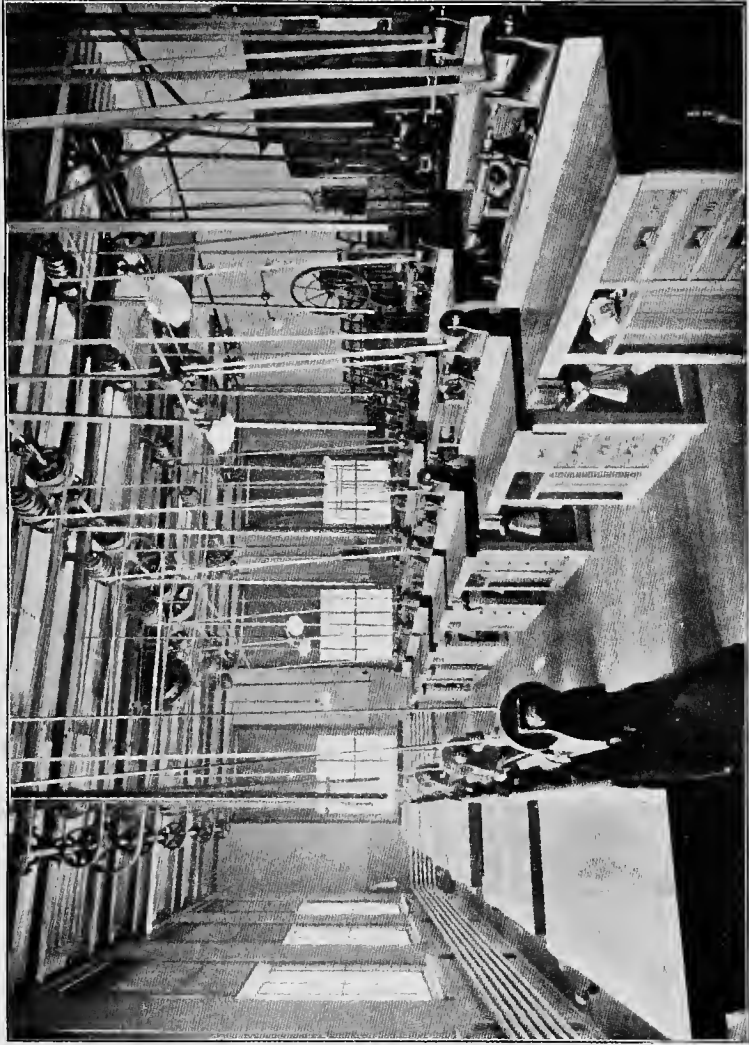
developed into a distinct type of school, preparing boys for industries and commerce, and for the higher institutions of science and technology, and has served as a model for the

**Origin of Manual
Training in
High Schools.**

manual training high schools which are found in every important city. After a quarter of a century's experience, the St. Louis Board of Education are rearing two splendid structures to house two manual training high schools. Several of the leading cities have at present manual training high schools under construction, these varying in size and in cost from £75,000 to £150,000. Several causes have contributed to the development of this particular type of institution—revolt against the exclusively classical education and reaction against the influence of the Universities; the technical education movement; the attractiveness of their programme for active youths of fourteen to eighteen years of age; and the spread of kindergarten ideals. Perhaps these may all be summarised in Sir William Hamilton's saying, that "self-activity is an indispensable condition of improvement."

It is worth noticing that the manual training movement began in institutions of university type, has spread downwards, and is relatively more extensive in high schools than in elementary schools. It will be remembered that the British Royal Commission on Technical Education suggested in their preliminary report an experiment in workshop training in elementary schools of England, and that the British movement has spread outwards to a very considerable extent, though not so much upwards. Very different results are due to the different points at which the movement began in the two educational systems—the manual instruction of British elementary schools is far in advance of that in the States; the laboratory and workshop provision, and the character of the manual instruction in higher institutions in the United States, are much in advance of those in the United Kingdom.

It was also very interesting to note that the two main ideas which underlie the formulation of manual instruction programmes, (1) that of Della Vos, who from the first required every shop exercise to be preceded by a working drawing, and who had the industrial value of the instruction in mind; and (2) the Swedish idea that every piece of shop-work must be a completed and useful article—have, according to their influence over the minds of the instructors, produced work of very different characteristics. Some of the schools are distinctly technical schools; others have merely widened the curriculum of a general education. The relative distribution of time between manual instruction, drawing, and science, on the one hand, and academic studies on the other, differs greatly, and has produced curricula which vary from those that prepare for the arts curriculum of a college to those which prepare for the scientific colleges and technological institutes. These higher institutions give credits for both the science and shop practice of the manual training high schools, the credit freeing pupils from the obligation of attendances at certain junior courses in the same subjects and admitting at once to higher courses. In time these credits will lead to a higher standard of admission. The manual training high



Wood Turning Laboratory.—Brookline Manual Training High School.



Machine Tool Laboratory.—Brookline Manual Training High School.

schools have not been free from criticism or attack, the attack being concentrated on the trade aspect of the instruction. Again and again have the classical legions assailed the position : *At tuba terribilem sonitum procul aere canoro increpuit : sequitur clamor, coelumque remugit.* The defenders only recognised the strength of their educational defences as the attack developed, and to-day the battle is over : the manual training high school is recognised as an organic part of the educational system.

Their final shape has not, however, been reached. They were attacked and defended as a separate structure through a lack of conception of the unity of the educational edifice, and their present form is due to the play of industrial and educational forces on the one hand, and to the resistance of classical ideals and conservative school-mastering on the other. Several questions arise in connection with their present form :—

- (1.) Are the manual training high schools likely to become a compromise between the trade school on the one hand, and the academic high school on the other ; or will they ultimately develop into apprenticeship schools?
- (2.) Should Latin form any part of the curriculum of such schools?
- (3.) Should they form separate institutions, or should they form an added department to an academic high school?

I submitted the first two questions to Professor Woodward, of St. Louis, who, in addition to advising me generally as to the documents bearing on the development of these schools, kindly replied to the specific questions as under :—

“(1.) I do not think they will ever develop into apprenticeship schools. The matter of pure apprenticeship will be left to industrial establishments that wish to train boys for their shops and drawing rooms. While they will retain in their programmes of study a certain amount of literary features and thorough courses in science and mathematics on the one hand, and the theory and use of tools and materials with considerable variety on the other, the combination can hardly be called a compromise. It is rather eclectic in character, the choice being deliberately made with a view to incorporating into the curriculum subjects which are educationally and intrinsically the most valuable. Intellectual strength and vigour can be acquired by study and training in useful things just as well as by study and training in useless things. We scorn the inference, which seems to lie at the root of popular notions of culture, that the more useful a study is the less is its culture value ; and conversely the more useless a study is the greater must be its pure culture value. This inference has not always been made explicitly, but it is too generally implied.”

(2.) Should Latin form any part of the curriculum of such a school?

“Yes, by all means. A year's Latin if it does nothing else gives the student an idea of what we mean by grammar and what we mean by an inflected language, and it opens the door to all the Romanic tongues, and inevitably throws a great deal of light upon English. Moreover, it is by

no means certain that the graduates of the manual training high school may not subsequently take literary courses, or become lawyers, doctors, teachers, and journalists, although the world needs most of them as engineers, architects, and general managers. A boy who does not take Latin more or less, and a modern language, puts a stumbling block in his own way; he shuts the door in his own face, and the world is less open to him when he graduates. Our theory is that we should put no stumbling blocks before our pupils, and that we should leave all doors open."

It is not easy for one who made so brief a study of American schools to answer the third question. I prefer to give the answer of John Dewey, of Chicago University:—

"At first the difficulty of the problem was avoided or evaded, because distinct and separate high schools were erected to meet these purposes. The current now seems to be in the other direction. A generation ago it was practically necessary to isolate the manual training course of study in order that it might receive due attention, and be worked out under fairly favourable influences. Fifteen years ago the same was essentially true of the commercial courses. Now, however, there are many signs of the times indicating that the situation is ripe for interaction—the problem is now the introduction of manual training and commercial courses as integral and organic parts of a city high school. Demands are also made for the introduction of more work in the line of fine art, drawing, and music, and the application of design to industry, and for the introduction of a larger number of specifically sociological studies—this independent of those studies which naturally form a part of the so-called commercial courses. At first sight, as just intimated, the introduction of these new difficulties before we are half-way through our old ones is exceedingly distressing. But more than once the longest way around has proved the shortest way home. When new problems emerge, it must mean after all that certain essential conditions of the old problem had been ignored, and consequently that any solution reacted simply in terms of the recognised factors would have been partial and temporary. I am inclined to think that in the present case the introduction of these new problems will ultimately prove enlightening rather than confusing. They serve to generalise the older problems, and to make their factors stand out in clearer relief. In the future it is going to be less and less a matter of worrying over the respective merits of the ancient and modern languages, or of the inherent values of scientific *versus* humanistic study, and more a question of discovering and observing certain broader lines of cleavage, which affect equally the disposition and power of the individual and the social callings for which education ought to prepare the individual. It will be, in my judgment, less and less a question of piecing together certain studies in a more or less mechanical way, in order to make out a so-called course of study running through a certain number of years, and more and more a question of grouping studies together according to their natural mutual affinities and reinforcements for the securing of certain well-marked ends."

One word more. In the classical high schools girls outnumber boys in the proportions of 4 : 3; in the manual training high schools boys and girls are in the proportions of 3 : 2. The premises and equipment are, in general, good; some are lavish. The equipment comprises wood-working shops, metal-working and machine shops (including large and well-appointed blacksmith's shops), drawing rooms, well-equipped chemical and physical laboratories, the last including electrical laboratories, and these containing a large amount of equipment suitable for junior courses in electrical engineering. The character of the instruction in science and manual training may be fairly well

estimated if it is understood that the teachers, being in accredited high schools, have to keep an eye on the scientific colleges and institutes of technology. "Heuristic"

Character of Science Teaching. ideas have not penetrated into them. The character of the science instruction in

American high schools generally is, I have no hesitation in saying, far in advance of that in the German gymnasia; and the only schools on the Continent which are fit to be compared with the manual training high schools are the *Ecoles Primaires Supérieures* of Paris. The American buildings and equipment are, for science teaching, in advance of those of British secondary schools, but in ideals and generally in methods of science teaching, the British secondary schools, imperfect though they are, are I believe, unequalled.

But American high schools are free! We want the funds which the Americans have; and we want the sentiment of democracy that education is that possession of the aristocracy which democracy most needs and can most readily obtain.

OCCUPATION OF THE GRADUATES OF THE MANUAL TRAINING
SCHOOL OF WASHINGTON UNIVERSITY, ST. LOUIS, AND OF
BALTIMORE, OHIO.

Occupation.	No.	Occupation.	No.
Agriculture and Stock raising.	14	Library.	1
Architects.	25	Mechanics.	16
Artists.	4	Merchants and Manufacturers.	101
Banking.	9	Ministers.	2
Book-keepers, general assistants, and clerks.	164	Physicians.	22
Cashiers.	5	Real Estate.	19
Chemists.	9	Reporters.	2
Contractors.	2	Salesmen and Agents.	41
Dentists.	5	Students.	89
Draftsmen.	117	Superintendents of Manufac- tories.	49
Electricians.	27	Teachers.	47
Fieldmen.	4	Technical Engineers.	108
Foremen.	4	U. S. Navy Engineers.	5
General Managers.	32	Miscellaneous.	12
Insurance.	9	Unknown.	65
Lawyers.	30		

MANUAL TRAINING HIGH SCHOOL, WASHINGTON, D.C.

Four Year Course B.

First Year.	Second Year.	Third Year.	Fourth Year.
English, . 4 History, . 2	English, . } 5 History, . } Geometry, . 5	English, . 4 Solid Geometry, } 5 Trigonometry, } Surveying, . }	English, . 4 Advanced Mathematics and Reviews, . 5
Algebra, . 5	German, . 3 Physics, . 4	Chemistry, . 4	German or French, or Physics or Chemistry, . 4
Drawing : Freehand, . 2 Mechanical, . 2	Drawing : Freehand, . 2 Mechanical, . 2	Drawing : Freehand, . 2 Mechanical, . 2	Drawing : Freehand, . 2 Mechanical, . 2
Shopwork : Joinery, . } Woodturning, . } Patternmaking, . } 4	Shopwork : Forging, . } 4 Foundry Work, . }	Shopwork : Machine shop- work, . 4	Shopwork : Machine shop- work, . 4
Domestic Science : Cooking, . } Domestic Art, . } Plain Sewing, . } Dressmaking, . } 4	Domestic Science : Laundry, . } Domestic Art, . } Dressmaking, . } 4	Domestic Science : Domestic Art, 4 *	Domestic Science : Domestic Art, 4

* German, or French, or Physics, *Optional*.

MANUAL TRAINING HIGH SCHOOL, NEW YORK.

Required.	Period	Required.	Period.
FIRST YEAR.		SECOND YEAR.	
English, ...	5	English, ...	3
Latin, or German, or French,	5	Latin, or German, or French,	5
Algebra, ...	-	Plane Geometry, ...	4
Biology, including Physio-	4	Greek and Roman History,	3
logy, Botany, and Zoology		Vocal Music, ...	1
in different parts of the		Drawing, ...	3
year.		Forging or Cooking, ...	6
Vocal Music, ...	1	German, ...	5
Drawing, ...	4	French, ...	5
Joinery or Sewing, ...	6	Chemistry ...	5

MANUAL TRAINING HIGH SCHOOL, NEW YORK.—*con.*

Required,	Period.	Required,	Period.
THIRD YEAR.		FOURTH YEAR (proposed).	
English, ...	3	English, ...	3
Latin, or German; or French,	5	A foreign language, ...	4
English History, ...	2	Chemistry, or Physiology, or Biology.	4
*Physics, ...	5	English and American History, and Civics.	4
†Geometry and Algebra (second course).	3	Drawing, ...	1
Drawing, ...	2	Machine Shop practice, or Domestic Science and Art.	6
Printing or Millinery, ...	6		
<i>Electives.</i>		<i>Electives.</i>	
Botany or Zoology, ...	4	Physics, as in Third Year,	4
German, ...	4	Latin, ...	4
French, ...	4	German, ...	4
Stenography and Typewriting.	4	French, ...	4
Book-keeping, ...	3	Mathematics, ...	4
Economics, ...	3	Stenography and Typewriting.	4
		Commercial Law and Commercial Geography.	5

* A student preparing for college, who has already taken two foreign languages may substitute a third foreign language for science specified. At least one period a week of Physics shall be devoted to unprepared work.

† Book-keeping may be substituted for Geometry and Algebra.

BROOKLINE, MASSACHUSETTS, MANUAL TRAINING HIGH SCHOOL.

One or two modern languages ; prepares for scientific and technical schools.

Required.	Period.	Required.	Period.
FIRST YEAR.		SECOND YEAR.	
English Literature, half year,	5	English, ...	2
Ancient History, ...	5	Mediaeval History, ...	3
Mathematics (Algebra. Geometry.	4	Mathematics, ...	3
*Zoology and Botany, ...	4	Mechanical Drawing, for boys.	4
*French, ...	4	Manual Training, ...	4
Mechanical Drawing, for boys,	4	Domestic Science, for girls,	4
Manual Training, ...	4	Art, ...	2
Domestic Science, for girls,	4	†Needlework, ...	2
Art, ...	2	†Physical Geography, ...	4
†Needlework, ...	2	†French, ...	3
		†German, ...	5
THIRD YEAR.		FOURTH YEAR.	
English Literature, ...	3	English Composition, ...	2
Modern History, ...	3	English Literature, ...	3
Mathematics (Algebra, Geometry.	4	Mechanical Drawing, for boys.	2
Physics, ...	-	Manual Training, ...	4
Mechanical Drawing, for boys,	4	Domestic Science, for girls,	4
Manual Training, ...	4	*Physics, ...	5
Domestic Science, for girls,	4	*Chemistry, ...	5
Home Decoration, ...	2	†Political Science, ...	3
†French, ...	3	†French, ...	3
†German, ...	5	†German, ...	5
†Needlework, ...	2	†Mathematics, ...	5
		†History of Art, ...	1
		†Needlework, ...	2

* Alternatives.

† Electives.

A period—50 minutes.

CHAPTER III.

TEACHERS AND TEACHING.

The training and qualification of teachers in the United States is possibly the most difficult feature of American education to form a just estimate of. Much of the difficulty lies in the conditions that govern the standard and requirements of licence or certificate; and much, also, in the fact that the prizes of the profession are open to all. An elementary schoolmaster may, and not unfrequently does, become a high school assistant or principal, a city or State superintendent, a professor or dean of a teachers' college (university institution). These two features—licensing and promotion—are like two opposing forces, one unfortunately not excluding the unqualified, the other stimulating the study and research of those admitted. Licensing has been largely the result of examination; and in some municipalities the conditions of admission to, and service in the teaching corps are somewhat analogous to those of our own Civil Service; in others they are of a very temporary character. The authorities empowered to grant licences are innumerable: democracy, as already pointed out, vesting its authority in the urban, county or "town" committees.

In Massachusetts, *e.g.*, there are 333 municipalities (or local authorities); and there are in theory as many standards of qualification as there are municipalities. Practically, however, the number of standards is much less; for a good number of cities and towns agree that the minimum qualifications shall be graduation from a State normal school, while some add to this qualification, successful experience. Owing to the number of licensing authorities, and, in consequence, to the number and difference of standards, a teacher, if moving from one city or county or town to another may be "torn up," or re-examined for licence to teach in the new locality. This is a grievous burden on teachers, and a great flaw in the educational system.

Further, the term for which the licence is granted varies very greatly. San Francisco and Chicago issue permanent certificates, and elect their teachers *ad vitam aut culpam*; the permanent certificate of Chicago City has, however, no binding force in the suburbs of Chicago, which are under county control. New York City issues temporary licences for the first

three years. At the end of the third year the licence is made permanent or rejected for permanency. If made permanent the teacher holds her position for life or until she retires at the end of thirty years on a pension. She may be removed for cause after trial by the Board. At such trial she has a right to be represented by counsel. On the other hand, however, the licence in many States is limited to a brief period, and the teacher is frequently, sometimes annually, on the rack. Even when superintendents are anxious to act otherwise, they find themselves blocked by the courts of law, which have held that Boards cannot bind their successors in the employment of teachers. Such conditions of license do not make for settlement. The vitality of a country which produces good schools and good teachers, in spite of such obstacles, is great.

In few things more than in providing a corps of competent teachers is intelligent central direction and some common standard, ground of action, and degree of permanence, necessary. The duty of securing a supply of competent teachers is too serious to be delegated to local authorities; and a central authority which did not undertake this duty would abdicate one of its functions. By "common standard"

**Absence of Central
Control.**

I do not mean to suggest a fixed percentage of marks in certain examination papers; I mean a common and reasonably high standard of general education, to which is superadded an efficient course of specialised and professional instruction. By the issue of a certificate legally valid, and of the same standard, throughout the whole of their administrative areas, the leading nationalities of Europe are, in respect of qualifications of teachers, considerably in advance of America. The making of citizens is a single aim. The individual must be separately treated; but the study of the method of treatment is of the same general character, and capable of the same general measurement as is the course of study of officers of public health or of public law. A common stamp of qualification is as necessary in the case of a teacher as of a doctor. Most Americans admit this; and the great variety of standard of qualification is not due to reasoned experience, nor to delegation or abdication of functions on the part of a central authority, but to the difficulty that the central authority—the State—only possesses such powers as are conferred on it by the local authorities.

The quality of a teaching corps depends very largely on the salaries offered. In New York City salaries of women begin at £120 a year, increasing by £8 a year to £240. By passing a special examination teachers may have their salaries raised to £288. A male principal of an elementary school is paid £700, a female £500, and an assistant to a principal £320. In New York City High School, principals are paid £1,000. There is a pension scheme. The New York City salaries are possibly the best in the States; and in consequence New York is attracting an excellent corps of teachers.

Teachers' Salaries.

In Massachusetts the average salary of a male teacher is £274 a year; of a female, £102. In some cases the "towns" pay as little as £35 a year; domestic servants have £35 a year, and board in addition! In Chicago, men and women are paid the same salaries, assistant teachers in elementary schools beginning at £110 and rising to £200. In Springfield, Massachusetts (population, 70,000), one of the best organised cities in the States, the maximum salary for principal of a high school is £600; for principals of elementary schools, £300 to £400; for assistants not in charge of rooms, £75. In the State of Illinois the average monthly wages paid to male teachers is £12; to female teachers, £10 10s. Carpenters in New York may obtain 4½ dollars a day! Any statement of teachers' salaries would be inadequate did it not include some mention of the salaries of superintendents—the executive officers of the local authorities. These officers are recruited from the ranks of the teachers (male and female), and are a necessary part of the school system. In Massachusetts the law required, after July 1st, 1902, every town and city of the State, to employ a superintendent of schools. Some local authorities were large enough to require the whole time of a superintendent; where this was not the case groups of towns co-operated to secure a superintendent's services. Altogether there are 186 superintendents in Massachusetts, a State with a population about as large as that of Wales. Their salaries vary from £200 to £1,200, the average being £375. The State pays half the salary in the case of towns under a valuation of £500,000.

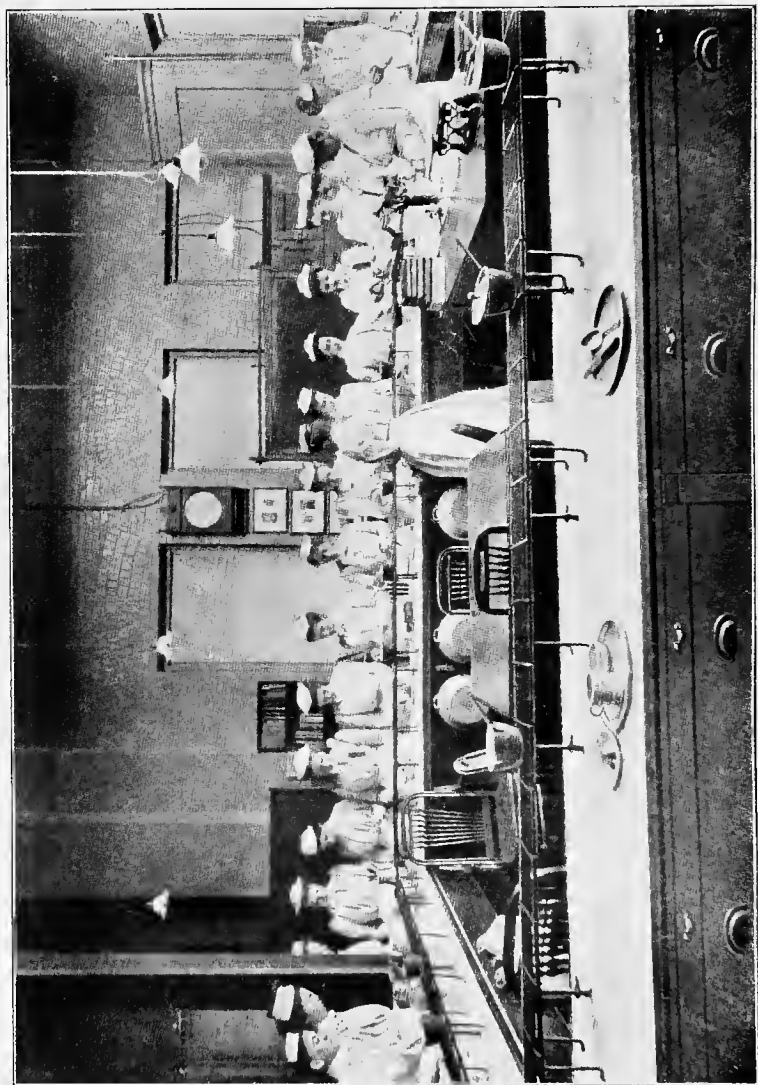
In endeavouring to form any comparison between the salaries of American teachers and those of the United Kingdom, the multiplying factor (see footnote, page 8) must not be overlooked. I find that the average salary of a certificated master of an elementary school in Scotland is £146; of a schoolmistress, £72; and this takes no account of free residences for 2,000 principals. In England these figures are £129 and £86 (not including free residences). In Ireland, the figures in this form are not accessible (see page 31 of 68th Report, National Board).

The salaries of headmasters of a fair number of elementary and secondary schools in Scotland are as good as those of New York; and in England many secondary schools could be pointed to, whose headmasters enjoy higher salaries, and that without including any of the great public schools. The figures given above show that the lowest salaries in the States are very poor; and that they do not compare favourably with those of skilled artisans, nor, indeed, in some cases, with those of factory operatives or of domestic servants. In consequence, teaching has become a woman's occupation.

In Massachusetts the ratio of women to men in the teaching profession is 10 : 1; in Scotland, 1·75 : 1; England, 1·6 : 1; and in Ireland, ·83 : 1. Men, in the United States, far more than in the United Kingdom, have been drawn away from teaching by the more lucrative attractions of the industrial



Children of the Pratt Kindergarten—Gardening.—Pratt Institute, Brooklyn.



Department of Domestic Science—Cookery—Normal Class.—Pratt Institute, Brooklyn.

and commercial world. The salaries offered, added to the prospects opened up by the higher posts of principal and superintendent, while low for men, are, on the whole, good for women; and consequently, the women teachers as a class are excellent. As a factor in estimating their qualities, it should be remembered that the American girl is not a "stay-at-home"; she is as anxious as her brothers to earn her living and be independent. There is considerable competition for appointments; and the ranks of the teachers have been of late years recruited from admirable material. It is obvious that for work in an infant department, women are naturally superior to men; and in the "standards" this may also be the case. I saw, too, many excellent teachers

Women Teachers. (women) of higher grades or standards handling classes and groups of classes of pupils (boys and girls) of fourteen and fifteen and sixteen years of age as well as any man could do. For educational work a good or bright woman is better than a poor or dull man; and one can readily appreciate that government of older pupils by head alone might be very effective—the woman can adopt no other means with the average boy of fifteen. I feel there is not yet, however, a sufficient body of experience to indicate the effect on Americans of leaving the common school teaching almost entirely to women. This subject should yet be regarded as an open question.

With regard to the qualifications of those admitted to the teaching profession, the standard of knowledge has frequently in the past been as low as, say, a leaving certificate from an elementary school, without the addition of any normal school training. This recalls to mind our monitors and pupil teachers—a class of teachers not to be found in the States. Though the attainments of many of the American teachers, and especially of those of rural schools, were of the same standard as that of our pupil-teachers and monitors at the beginning of their apprenticeship, the Americans had an advantage in maturity, being adults. Owing to the effective agitation of the teachers' associations, on which, as has already been pointed out, have devolved the functions of a central authority in setting up ideals, teachers' qualifications are being gradually raised to a good standard. The chief obstacle in the way of the associations is, however, their difficulty of agitating for increase in salaries. It is not easy for teachers to secure a public hearing, when they endeavour to point out that if the public want efficient teachers they must pay for them. In spite, however, of obstacles, a great change has been effected of late years; and the best local and State authorities are now leading the way in demanding for an elementary school licence or certificate—

Standard of qualification rising.

- (1.) A high school education; and
- (2.) At least two years' professional training in a normal school (training college).

Too much time has of necessity been given in American normal schools, as in our own, to general education. Such work was inevitable, the standard of attainment of entrants being very low; so low, in some cases, as the standard of a leaving certificate of an elementary school. Professional training has, consequently, been encroached on, and, to a certain extent, neglected. There is much to be

Training Colleges. said for the broader and deeper understanding of the subject-matter of languages, mathematics, science, &c., which the maturer years of the normal students permits, yet the professional studies ought to be looked upon as essentials, and as incapable of neglect, those studies bulking so largely as "supports" in a teacher's background when pupil and teacher are face to face in the classroom.

As in the case of the education of a physician or surgeon or engineer, so in the case of a teacher, it should be obvious that professional studies must demand a large part of the time of the student while in the professional (*i.e.*, the normal) school.

I brought away types of examination papers, and submitted to Dr. Morgan and his associate, Mr. Calderwood, of the Church of Scotland Training College, Edinburgh:—

- (1.) The examination papers set for admission to the Massachusetts State Normal Schools, on September 9th and 10th, 1902; and
- (2.) The examination papers set for graduation from high schools and for admission to training schools in the city of New York, in June, 1903.

I gave these gentlemen no indication of my views.

Dr. Morgan says:—

"The Massachusetts papers are, I think, more liberal and rational than ours, and do not enter into the petty details that frequently figure in the latter. The standard of difficulty of most of the papers is not so high as ours, but they more seriously attempt to solve the problem how best to test the student's intelligent knowledge of the subject, and they give more prominence to parts of it that bear on present day life and institutions.

"It is a wonder that the Latin, French, and German papers do not ask for translation from English into those languages, and that there is no oral examination in at least French and German.

"The Mathematical papers would be rather easy for our entrants, but I like the commonsense principles on which the papers are drawn up: there are no traps for the simple students—questions whose solutions depend on some artifice—no repeating decimals, and absurdly complex fractions. I would have expected to see more practical geometry in the paper, and problems to be solved by drawing to scale, but I think such questions are properly relegated to the paper on Drawing. The above remarks refer to the Massachusetts papers.

"In the City of New York papers, I like the wide choice of questions given, and the general standard is nearly that of our own. They correspond pretty closely to the Scotch Leaving Certificate of the different grades."

Mr. Calderwood says :—

"*English*.—Here, I think, the American papers are on much more valuable lines than our own. Several classics are evidently prescribed, and the questions set on them are excellent, in view of the fact that much of the life work of the candidates will consist in guiding their pupils to get behind the mere words of their books. To these papers our own, with their parsing and analysis, exaggerated blunders in the use of English, and literature questions of such a nature that they can be prepared for in the most mechanical fashion, present a very unfavourable contrast.

"*Arithmetic*.—I am of opinion that in this subject our own papers are the better type. In examinations of most recent date almost every question set is an example for the use of commonsense arithmetic methods; and, in the main, the papers could not have been on more healthy lines.

"*Mathematics*.—While our own papers are quite good, I think we might copy the Americans in the persistence with which they seem to demand simple proofs of well-known rules, as also the statement of important theorems applied to this or that computation.

"*History and Geography*.—Here again I think we have something to learn :—

1st. In the highly skilful and natural blending of History and Geography in the questions set.

2nd. From the fact that, in History, the questions set demand not merely the reproduction of matters of fact, but are of such a form as to compel the candidate to regard the story of his country from such points of view as will tend to make him a capital teacher of the 'Duties of a Citizen.'

"In *Languages* I see no good point in the American papers which is not well represented in our own.

"One feature in the setting of the American questions is, I think, excellent, namely, the giving under many of the questions three or four heads of the subjects to which the answer is to be particularly directed. When this is done, I notice that the paper always, and I think rightly, concludes with a question for independent treatment."

The professional work of the best normal schools includes psychology as a basis of principles and methods; school management, history of education, observation of good teaching, and practice under criticism.

A few facts in regard to the Normal School, Bridgewater (Mass.) may be interesting. This normal school was opened in 1840, and was the first normal school in the States for which a new building was provided. The institution is splendidly housed, the State having recently provided new building at a cost of £125,000. There are several courses

Bridgewater Training College.

of training :—(1) special; (2) four years; (3) three years; (4) two years. Since opening in 1840, 4,905 students have been admitted to the normal school; and 3,117 have graduated (*i.e.*, satisfactorily completed at least a two years' course); 253 have graduated from the four years' course. There were 280 students in attendance, 230 being resident pupils. City normal schools are non-resident and free. Rural girls, obviously, cannot as a rule live at home and attend a normal school; for such, resident normal schools are a necessity. Resident normal schools like Bridgewater charge fees—4 dollars per week for a woman, 4½ dollars for a man. The fees bring a good class of student. Of the staff of fifteen instructors, one had the degree B.A., one of B.Sc., two of M.A., one of Ph.D., and three others the equivalent of B.A., from courses taken at the Institute of Technology.

The staff alone decides as to "certification" or graduation at the close of the course, *i.e.*, they have no outside examiners. No prizes are given for examination work.

A consideration of the work of the training colleges led me into an examination of the character, in respect of training, of existing teachers in public schools. I find that in Massachusetts 46 per cent. of all teachers in the public elementary and high schools had been trained at a normal school. In Scotland, 55 per cent. of the teachers in public elementary schools, and in Ireland 53 per cent. of the principals and assistants in the service of the National Board have been trained at a training college. Among the "untrained" in Scotland are classed, however, a considerable body of the 1,100 university graduates, who are teaching in public elementary schools. These figures are to the disadvantage of the Massachusetts schools; and it would not be easy to show that any other State is in a better position. As a matter of fact, not 20 per cent. of all the teachers in American public schools are graduates of normal schools.

But as I have already frequently pointed out, things educational in America are improving rapidly. To-day, in the nine normal schools of Massachusetts there are 1,684 students; in Scotch training colleges, 1,382, and in Irish, 976. The respective populations are—2,856,000, 4,521,000, and 4,459,000. These figures are greatly to the advantage of the Massachusetts schools; and were the Massachusetts ratio extended to the whole of the States, we should find 50,000 students in normal schools. It is, however, doubtful if there are 30,000.

The training of teachers for high schools follows in essentials the same lines as that for elementary schools. By general consent a college education two years in advance of a high school education is demanded as the degree of scholarship preliminary to professional training. Several of the leading universities have a teachers' college ranking with the schools of law, medicine, &c., as one of the professional schools of the university. In the teachers' college at Columbia University, New York, there are 709 students in training for educational posts, chiefly in secondary schools. The courses in education leading to a Bachelor's degree are:—

- (1.) Preparation for teaching any one of the subjects of a secondary school curriculum.
- (2.) Preparation for teaching in elementary schools.
- (3.) Preparation for teaching in kindergarten schools.
- (4.) Preparation for teaching domestic arts.
- (5.) Preparation for teaching domestic science.
- (6.) Preparation for teaching fine arts.
- (7.) Preparation for teaching manual instruction.
- (8.) Preparation for teaching music.
- (9.) Preparation for teaching in primary schools.

Of the pre-requisites for courses of training such as 4, 5, 6, 7, 8 and 9, it is important to notice that candidates for admission to these courses must give evidence of (1) having completed a satisfactory course in an approved secondary school, and (2) of collegiate study or technical training during a period of at least two years following the secondary school course. The staff of professors, assistants, and instructors is very large; and there is also a large clerical staff. The appointments of the teachers' college are wealthy; the surroundings somewhat luxurious and æsthetic. There are a certain number of scholarships. Teachers come to this college from all parts of the States to extend their general and professional studies. The students may be roughly divided into three groups:—

(1.) Those who, being teachers, come from long distances (California, *e.g.*) with a definite object in view, such as to qualify for a promised teachership of a new subject, say domestic economy, or for a supervisorship of some subject, say manual instruction.

(2.) Those who, having held positions, are afraid they may lose them owing to lack of special knowledge, and ask for leave of absence in order to attend the training college.

(3.) Those who have no definite appointment in view, but are in training for teacherships.

Class (1) is due to a somewhat common feature of the American school system, as it is also of the industrial system. Just as an engineer may save a little money and leave his "works" for study at an institute of technology, so teachers leave their post and attend teachers' colleges in order to qualify to retain a post or secure a higher one.

Chicago Teachers' College has 100 students in training. Time did not permit my visiting any others. Clark University makes a special feature of psychology for teachers, laying great stress on laboratory work in that subject. The President, Dr. G. Stanley Hall, is by many regarded as the leader of thought on scientific education—not education in science—in the States; and he has brought a good many teachers under his influence. Those interested in obtaining some idea of the man and his work should read the "Confessions of a Psychologist" in the *Pedagogical Seminary* for March, 1901.

The influence of the Teachers' Colleges over elementary and secondary education is great, and is spreading; the direction of the influence is towards—

(a.) Having something to teach, *i.e.*, special knowledge of some subject; and

(b.) Psychology as a basis of a teacher's work.

It appears to me, from what I have seen in the States, that while the standard of attainment of American elementary and secondary school teachers in the different subjects of study is not so high as the British, yet a large proportion of American teachers have a clearer

insight into a teacher's work than the British have. Their high schools do not yet include on their staff men with such special knowledge that they could step into a university chair, as is true of many masters in the great public schools of

**Estimate of
American Teachers'
Qualities.**

England; but teachers in high schools and in elementary schools, as a rule, have a far clearer appreciation that teaching is a scientific business. The elementary and secondary schools have not had a "results" system; and it is interesting to observe that while the results system has led to intenser study, or to greater stress on the mechanical features of study, in British schools, the absence of it in America has given greater freedom for experiment and for efforts at true teaching. The American teacher appreciates that her influence on the child's mind must be curative, directive, and formative; and she understands that the subject-matter of study is merely the material of growth; but may under circumstances form the material for arrested development. The best of them endeavour to diagnose mental phenomena as a physician diagnoses physical symptoms; and to administer the proper nutritive material just as the physician prescribes his dietary. They have studied genetic psychology, and realise the peculiarities of

**Value of the Teachers'
Training.**

childhood and adolescence; they may have even made a special though a brief study of abnormal cases, and have arrived at the knowledge that abnormal tendencies of childhood and youth are but the "physical reverberations of long past ages"; that the "mischievous" pupil is not quite his own master. The American teacher is what she wants the child or youth to become—dignified, balanced, and self-poised. (I listened for the high notes of an over-strung teacher, but never once detected them.) Her sympathy is of the calm and practical, not of the hysterical order. American women teachers are as free from nerves as from affectation; they are at ease with their work; and they can handle classes of youths of fifteen or sixteen or a floor of several classes as well as any man, and, I should think, better than most of their male colleagues in the elementary schools in America. The male colleagues in the elementary schools as a rule are not the intellectual equals of the woman teacher. In the classes there is a good deal of "orderly disorder"; the teachers striving to counteract the machine-like discipline of a large class or large school—which is partly the outcome of, and certainly good for, the factory system of industry—and to keep it below the point at which it begins to benumb, believing that intelligence and automatic movements vary in inverse ratio.

The pupils are not "turned down" (or "sat upon") for their answers, as they are so often with us: the answer, if insufficient, is discussed and enlarged, and the pupil himself brought to realise its insufficiency. But teachers show, however, fairly frequently the defects of such virtues. Programmes of study are found full of novelty: the subject-matter

of lessons is pieced together illogically—beads without a string. And indeed, subjects are discussed and answers analysed leading to questions that cannot be answered, and to nothing; the teachers themselves not having a sufficient reserve of knowledge, and not leading the class with sufficient judgment. This is not due to intrinsic defects in the study of pedagogy; but to adventitious and incidental faults in what is not yet a definitely formed system, but only the formative process out of which a system is being evolved. Average teachers in British elementary or high schools would, possibly, pass an examination in the subjects they teach higher than that of similarly graded American teachers; and British pupils are certainly in advance in their studies—at eighteen years of age by one or one and a-half or even two years—of the American pupils of the same age; but this is not the conclusion of the whole matter, for the governing ideal of the British system is too much the making of scholars; that of the Americans is clearly the making of citizens—knowledge of ours; how to transform knowledge into power, of theirs. In this the spirit of the young American aids: the boy (and the girl, too) sees a vast world in front of him with enormous prizes, and his young ambition is fired—he wants to try his strength, and wants to find his school work and knowledge usable.

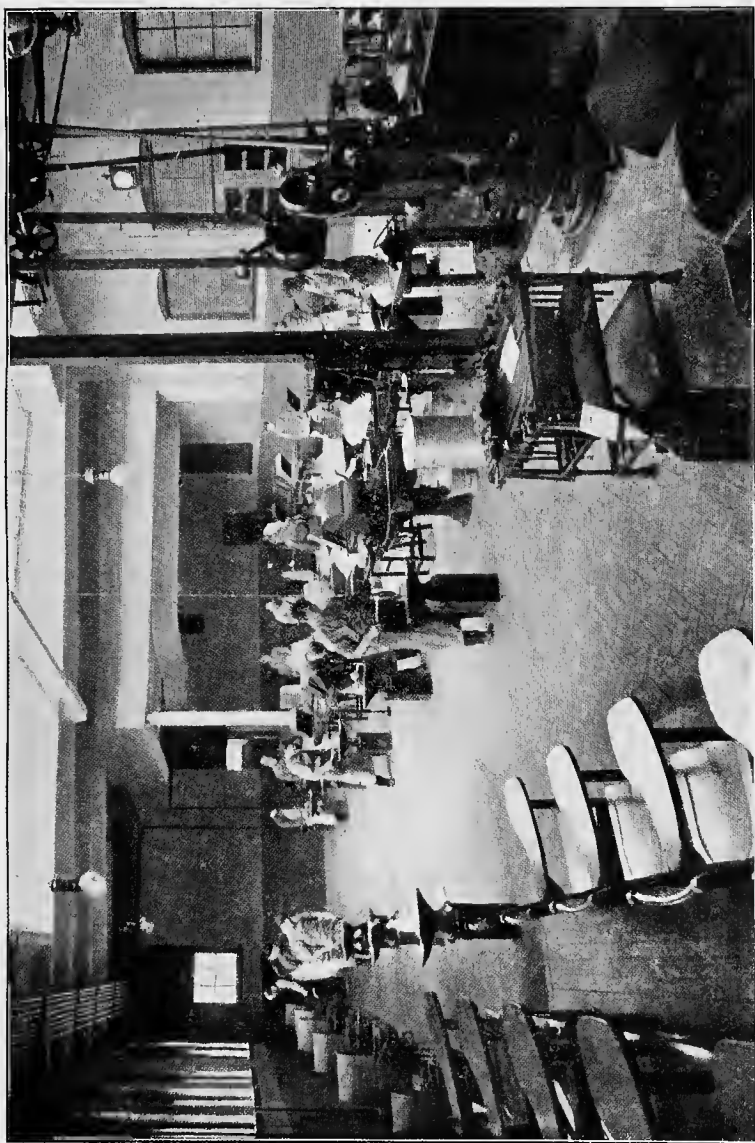
There is one feature of a teacher's work which might with advantage be copied. I found on arriving at the Classical High School in Springfield that it was closed. As I was accompanied by the superintendent I was anxious to hear his explanation; but it did not come quite readily. After a moment or two, he suggested that the school was taking one of three holidays allowed per year to the staff of each school in order to visit and see other schools at work; and this suggestion was later seen to be the complete explanation. Some of the staff were found looking into the work of other schools. Such a principle extended to the case of superintendents and college professors means often a "Sabbatical year." For six years, or as agreed upon, the superintendent or professor takes the minimum holiday; or the seventh he is free, sometimes on full pay, sometimes on short pay, sometimes without pay; but the post remains for the teacher's return. Such a term of rest leads to research in new directions: it has enabled many American teachers to study European systems.

Reference has already been made to the influence of teachers' associations on the development of a fairly symmetrical system of public education in the States. In the absence of a Central National Department of Education, holding up ideals and stimulating school work, ideals have been formed and programmes and syllabuses formulated by conference and associations of teachers, and in a special degree by the National Education Association.

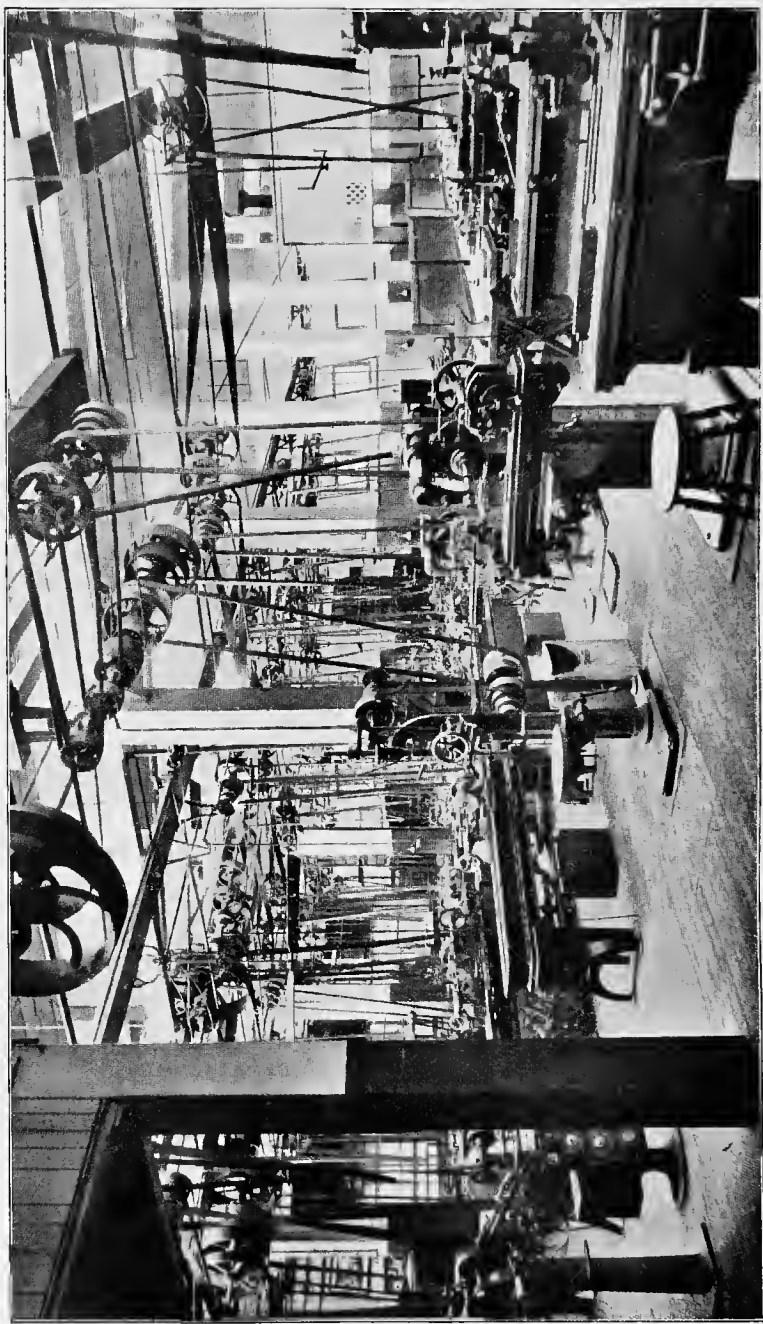
Teachers' Associations. These associations are here called *teachers'* associations by way of comparison with the British analogues; but, as a matter of fact, they are in some important

respects without a parallel anywhere. Consultations and conferences of teachers and officials are common; conferences of principals and other members of their staff are frequent. County, city, and State conferences and associations—in which teachers and officials discuss matters of common concern, might be paralleled in Europe; but there is nothing analogous in size, in composition, and in character of work to the National Education Association, which includes presidents and professors of colleges and universities, teachers in secondary and primary schools, officials of National, State, and local authorities; leading librarians and editors of educational publications. If there are classes in America, educators form one class; no grade or distinction exists within the class, except that of ability. The frequent personal contact of leading educators and exchange of views act and re-act on all grades of educational work, and induce a high and wholesome tone throughout the service. The National Education Association, formed in 1857, and consisting, at first, of but a few enthusiasts—previous to 1884 the annual meetings were attended by an average of 200 members—has now become an institution of gigantic proportions. Since 1895, the average attendance at the annual meetings has exceeded 10,000; and at the 1903 meeting, in Boston, over which Charles W. Eliot, President of Harvard, presided, 35,000 members were present. Many of these were, no doubt, attracted by the cheap trips and the “side shows,” but the agenda paper of each of the eighteen departments—the National Council of Education, Kindergarten, Elementary, Secondary, Higher, Normal, Superintendence, Manual, Art, Music, Business, Child Study, Physical Training, Science Instruction, School Administration, Library, Special—forms an excellent bill of fare.

The early efforts of this association secured the establishment by Congress of the Bureau of Education of the United States, and of the office of United States Commissioner of Education; and the report of its various Committees—of Ten, on secondary; of Fifteen, on elementary, schools; of Twelve on rural schools; of the committee on college entrance requirements; of that on normal schools; and of that on the relation of public libraries to public schools, are classic publications; those of the committees of Ten and Fifteen having an influence far beyond American institutions. The two reports last referred to recall the “Curricula and Programmes of Work for Higher Schools in Prussia,” issued by the Prussian Education Department as the result of the Berlin Conferences of 1890 and 1900. Both sets of documents represent in condensed form the best thought of their respective countries on certain aspects of National Education. British students of education have to read through many Reports of Commissions to gather anything like the same body of ideas. The two American documents are, in my opinion, more masterly works than the Prussian. They will not, however, be so useful as the Prussian, for the American are, of course, optional; the Prussian are obligatory. The absence of central control is the weak spot in American education.



Forging Laboratory.—Brookline Manual Training High School.



Portion of Machine-Tool Laboratory.—Massachusetts Institute of Technology.

CHAPTER IV.

TECHNICAL EDUCATION IN THE UNITED STATES.

The term "technical education" has several connotations: sometimes the strictly mechanic arts point of view is adhered to; sometimes it is understood as that form of education which helps a man to earn a living. In the latter sense there is little that it cannot include: ancient and oriental languages for printers; Latin for solicitors, pharmaceutical chemists and medical students; divinity; surgery; engineering; agriculture; hedge-cutting; hair-cutting; car-driving, and chimney-sweeping. The second is the more popular view.

"Technical education" has also been defined in Acts of Parliament; a leading feature of the definition being the prohibition of the teaching of trades. The same Acts, however, allowed the inclusion of subjects other than those named in the definition, if approved and "minuted" by the central authority. The authorities, local and central, responsible for technical education being responsive to public opinion, subjects following the lines of the more popular interpretation have from time to time been added, and highly ingenious arguments

Technical Education.

have been multiplied to show that trades were not being taught. The "last ditch" of the defence may be stated somewhat thus: Under industrial conditions the worker's operations are restricted in number and character in such a way that he must not only have the requisite skill to carry out the operation, but that he must repeat the operation so frequently that he tends to become a part of the machine—although a self-adjusting part, such as mechanical engineers have not yet been able to make out of wood or metal. Technical education, on the other hand, it is argued, promotes an opposite tendency in the individual; it affords opportunities for increasing the number of his operations, thus helping him to acquire manual skill of a more diversified character; and it also gives him the underlying theory of tools, materials, and processes. Such a view, added to the funds available for promoting it, has produced a British system of evening schools without parallel anywhere. I have seen the German evening school system and the American evening school system, and neither is comparable with the British in quantity or in quality. German and American educationists have a very high opinion of British evening schools; but they look upon them as trades schools—institutions for the training of highly skilled operatives. Such is not a wholly incorrect view. Germans and Americans point with no unnatural pride to their Charlottenburgs and their institutes of technology, and, not being able to see similar institutions in the United Kingdom, they form a poor estimate of the British system of technical education. They have "sized up" all British evening

schools as mere trade schools. They do not see that most of our able and ambitious young men and young women are to be found in these institutions adding a school evening to a workshop or counting-house day; they do not realise, and frequently we ourselves have failed to realise that we are *in the main* trying to do in one institution—the evening school—what Germans and Americans are *in the main* endeavouring to do in two. In other words, they separate more clearly than we do the education of the “hands” and of the “heads.” The complaint as to want of preparation of our evening technical students is, to a considerable extent, evidence of this analytical defect in our educational authorities: not being clear in our aims we are confusing the issues and are endeavouring to do too much with all the raw material placed at our disposal; we are endeavouring to use the same process for the production of both “heads” and “hands”; and are too apt to apply the standard for “heads” to the recruits for “hands.” Britishers have held on somewhat tenaciously to the belief that leaders are “born, not made”; they have trusted to the native ability of the “lad o’ pairts”; and they expect him by sheer force of character to learn his trade, attend the technical school, and fight his way to the top of his business or profession.

It will be observed that in referring to the two processes I have said “in the main” on both sides; for I am not overlooking our day technical institutions on the one hand, nor on the other that the American “lad o’ pairts” does “come through” by sheer force of character and ability, and with the aid only of evening technical schools, as ours do. I contend, however, that in the reservation “in the main” I have sufficiently allowed for the exceptions.

A few figures may corroborate my statements. In 1901 the total number of British day students of technology was 3,873. Of these, 2,259 were engineering students. (See Record of Technical and Secondary Education, Volume IX., No. 45, page 54). In the nine German technical high schools (day institutions) there were 14,986 students in 1902 (see page 49, Report by Dr. Rose); and in the scientific colleges and schools of technology (day institutions) of the United States, in 1900, there were—students of agriculture, 2,852; of mechanical engineering, 4,459; of civil engineering, 3,140; of electrical engineering, 4,459; of mining engineering, 1,261; making a total of 14,267 students, in addition to 10,925 students of general science courses (university and technological), including applied chemistry. (See page 1,875, United States Commissioners’ Report, 1901). In Charlottenburg alone, there were 3,428 day students in 1899, and 4,194 in 1902; in the Massachusetts Institute of Technology, Boston, 1,608 day students in 1902-3; and in the same year, Sibley (Scientific and Engineering) College of Cornell University had 886 day students. The numbers become even more significant when it

**Leaders made,
not born.**

is realised that the British totals include all day technical students of *fifteen* years of age and upwards, who were taking a complete day technological course of not less than twenty hours per week ; and that the schools contributing to these numbers varied from those of university standard, requiring a good general education as a preliminary, to technical schools, for which the only preliminary was an elementary school education. On the other hand the German students are not admitted until they are eighteen years old ; and the statistics of the Massachusetts Institute of Technology, Boston, which in this respect may be regarded as fairly typical of the United States institutions, contrast favourably with ours. In 1902-3, 22·5 per cent. of the Boston students were between sixteen and a half and eighteen years of age, and 77·5 were over eighteen, none being below sixteen and a half, and almost 15 per cent. being over twenty.

The German and American students as a whole have had a much better preparation than ours ; they show their high school leaving certificates as admission cards.

These figures fully support my view that German and American leaders on the one hand, and British on the other, are prepared in different ways—the American and the German mainly in day schools ; the British mainly in evening schools. There are, of course, some other factors ; but I am dealing only with the educational.

The institutions which I visited, and from which I formed my impressions of technical education in the States, were :—

The New York City Evening Schools, including—
 The New York City Trade School ; and
 The Cooper Institute, New York ; and
 The Pratt Institute, Brooklyn.
 The Springfield (Massachusetts) Trade School ;
 The Drexel Institute, Philadelphia ;
 The Lewis Institute, Chicago ;
 The University of Pennsylvania, Philadelphia (Wharton School of Commerce) ;
 University of Illinois ;
 Harvard University ;
 Massachusetts Institute of Technology, Boston ;
 Cornell University.

Sibley College (Cornell) and “ Boston Tec.” are engaged in the preparation of the *leading officers* of the industrial world. These two institutions hold a deservedly high place in the public mind, owing to their influences on education and on industries. They are the best of the many institutions one sees ; but what is true of them is in varying, though less degree, true of the others.

The Pratt, Lewis, and Drexel, are institutions of a secondary character. The standard required of entrants, and the duration of the course, differ considerably from that of Cornell

University and "Boston Tec."; and, as a rule, they turn out the *petty officers*, men to hold the intermediate positions, below the chief engineer and the general manager on the one hand, but above the skilled mechanic on the other.

The evening trade schools train the "*hands*."

The aims of these three sets of institutions are not so clearly defined as I have indicated; but I am confident that this classification does them no substantial injustice.

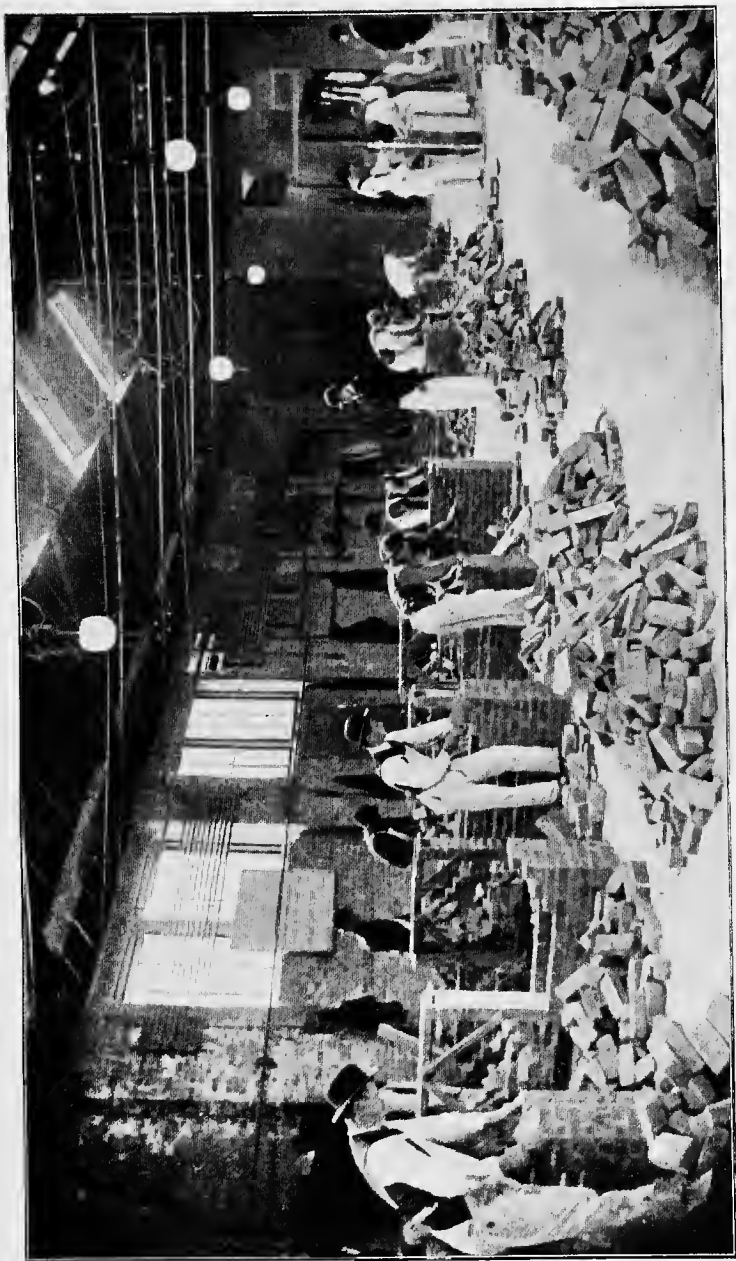
Let us take the last first. Some of the trade schools have no higher aim than conversion of unskilled labour into partly skilled labour. In one of the most important of these institutions the teaching was trade teaching of the clearest character with little thought of the "last ditch." Some of the instructors were Trades Unionists, and there appeared to be no active Trades Union opposition to the avowed objects of the school. In only one class (painters and decorators) was instruction restricted to students daily engaged in the trade. The other classes were made up of men who were not in the trade, but who, after a session's work, slipped away into the country and gradually worked their way back into the city as recognised tradesmen. Classes meet three nights per week, two hours each night; six hours per week for six months. Attendance is very regular, and the students are very keen; they mean business. Some of the metal industry trade schools aim as high as the making of the most skilled machinists and foremen—men who can take work at any hand or power machine, and who can read drawings. The work done in these schools is on a trade scale. (See illustrations, pp. 48, 50, 75.)

The schools (day and evening) of a secondary technical character, may be said to stand in the same relationship to the front rank institutions, such as "Boston Tec." and Cornell, as high schools do to colleges. They aim at taking students of sixteen or seventeen years of age, whose general education is equivalent to that of the first two years of a high school, and who desire to specialise instead of proceeding with a further course of two years of general education.

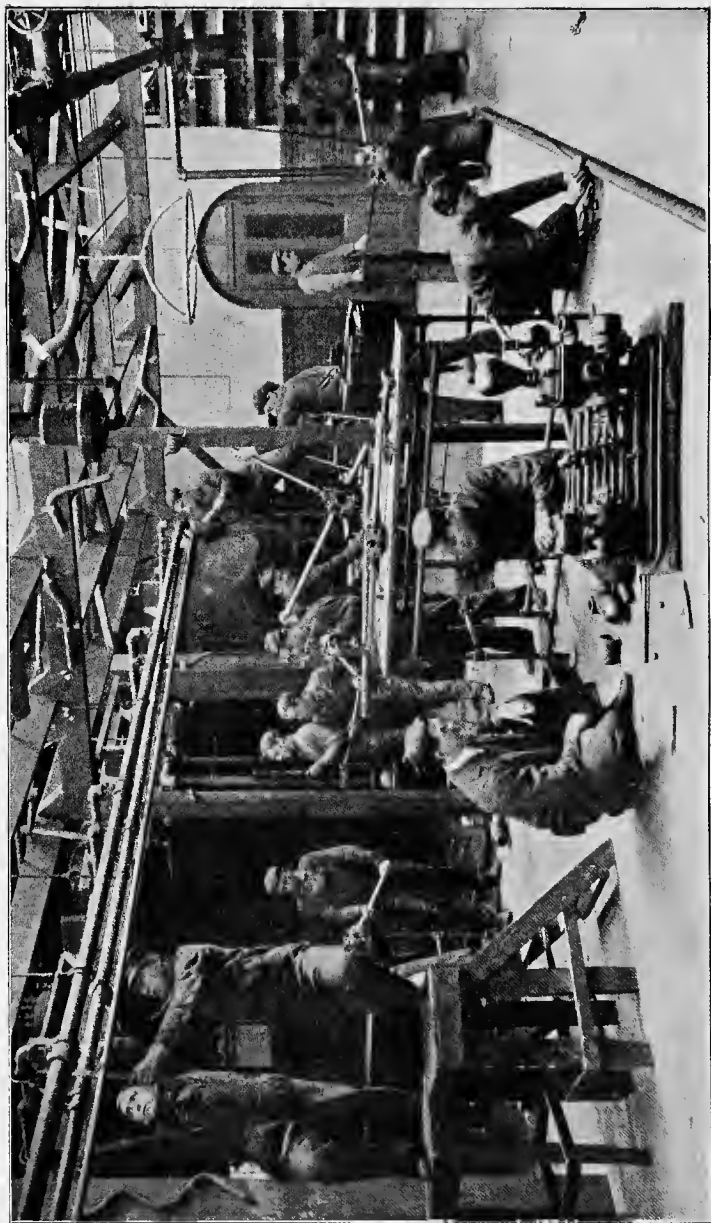
The following extract from a paper on secondary technical education by Dr. Williston, Director of the Department of Science and Technology, Pratt Institute, is well worth serious consideration. The expert sets out clearly the ideas which govern the two years' day engineering courses in the Pratt Institute:—

"Both in the draughting-room and shops of all our mechanical and electrical industries is this demand becoming more urgent for men who have had sufficient training in applied science to enable them to grasp and understand the plans of the engineer above them, and who have sufficient knowledge of practical details to direct the carrying of them into execution. And this demand is all the more urgent, because for every engineer and master of construction a dozen men of this other type are needed to carry out his plans.

**The Pratt
Institute.**



Bricklaying Department.—New York Trade School.



Steam Fitting Shop.—New York Trade School.

"Mathematics and physics are both fundamental to all mechanical problems, and should, therefore, enter prominently.

Day Engineering Courses.

Design and construction should also be emphasised. Each day, therefore, there should be instruction in mathematics, physics, physical laboratory, shop-work, and mechanical drawing. If the day is divided into eight periods, this gives one period for each of the two recitations in mathematics and physics, and two periods each for laboratory, drawing and shop-work. Add to this two hours and a half for evening study, and you have a day under which any healthy boy will thrive. Such a large part of his time is taken up by work requiring physical activity, that he finds his task a wholesome one.

"The mathematics of the first year should include algebra, plane geometry, and elementary trigonometry, but not taught from the ordinary text-books. The mathematics will give the best mental training and the broadest if it is closely allied to the other work, so that it may be more thoroughly understood in its meaning and its application. And as the young men are to enter the field of construction, all their school training will have the greatest educational value if it is closely allied in purpose and spirit to their life-work, so that the process of thought and education may continue without interruption after they leave school. Therefore, the mathematics should be made practical and constructive. The student should be made, not only in geometry but in all other branches, to construct his own proofs, and to build up step by step, under close and continual guidance, his own methods of reasoning.

"The physics, too, should be taught with special reference to the work that is to follow. Mechanics and certain portions of heat and electricity should be dwelt on; the remainder may be passed over more rapidly. The laboratory process should largely be relied on, and an effort should be made so to equip the laboratory with simple, yet effective, apparatus, that every principle of importance—either because it is fundamental to an understanding of what is to follow, or because of its application in practical work—may be studied through the medium of at least one laboratory exercise. The idea is to gain the desired end by *constructive steps based upon doing, rather than to attempt to reach it through the application of abstract logic*; and many portions of physics which, approached by any other method, would present mathematical difficulties beyond the powers of secondary school students, may thus be studied with considerable success. The experiments should have, wherever possible, a practical as well as a disciplinary value, and the prime requisites for the apparatus designed for the use of technical students of as mature age as those who will satisfy our entrance requirements: that the apparatus shall not be trivial, but shall be of a character to awaken interest; that it shall be capable of definite ends and useful purposes; and that it shall give quantitative results that will compare with those used in professional work.

"The drawing and shop-work shall be as practical as it is possible to make them, and in planning the work and the equipment it should be remembered that much may be left to the imagination of the college student, but for the student of our technical school no equipment is too good, and no thought and care in methods of presenting work to him is too great. In both drawing-room and shop pains should be taken to make use, wherever possible, of what has just been learned in the classes.

"In the time that is available for shop-work, it is possible to give a pretty thorough course in pattern-making, foundry-work, and forging in the first year. The drawing may be made to include geometric drawing or orthographic projection and shop detail and assembly (synthetic) drawings made from student sketches.

"The work of the second year may not be so clearly defined, as there is more room for individual judgment to vary the course of study; but the fundamental idea marked out for the first year will prevail in the second. I would suggest, however, the following:—Mathematics every day; a recitation in mechanism, mechanics, strength of materials, and steam, to take the place of the first-year physics; and the balance of the time

divided between machine design, machine construction in the shop, and mechanical laboratory, which now takes the place of the physical laboratory.

"In mathematics more advanced algebra, solid geometry, and some more advanced trigonometry, with the elements of analytical geometry, may be covered.

"In the machine shop ten hours a week may be had throughout the year, which gives a pretty thorough and complete course, and enables a good deal to be done in the way of tool-making, cutter and reamer grinding, &c., in addition to a large amount of machine construction; and the course in machine design may include design in machine details, and after the strength of materials has been taken up in laboratory and class-room, design involving strength calculations.

"In the mechanical laboratory and the class-room work that accompanies it, there is more room for variation than in any other point in the course. It may, however, include power measurement with indicator and brake; transmission of power with belt, rope, gears, &c.; measurement of friction losses; efficiency calculations; hydraulic measurements and efficiency of water-motors; steam experiments on calorimeter; flow of steam; injector; steam pump, engine and boiler tests, &c.; and much time can profitably be devoted to strength of materials tests. Much of this work will be conducted in a less exhaustive way than if it came in the senior year of a college course, but that does not mean that it has any less value in its place. An injector test, for instance, would be run to determine experimentally how much water one pound of steam would lift, and the results would be checked by the heat balance. The calculations involving the kinetic energy of the steam as it issues from its orifice would be omitted.

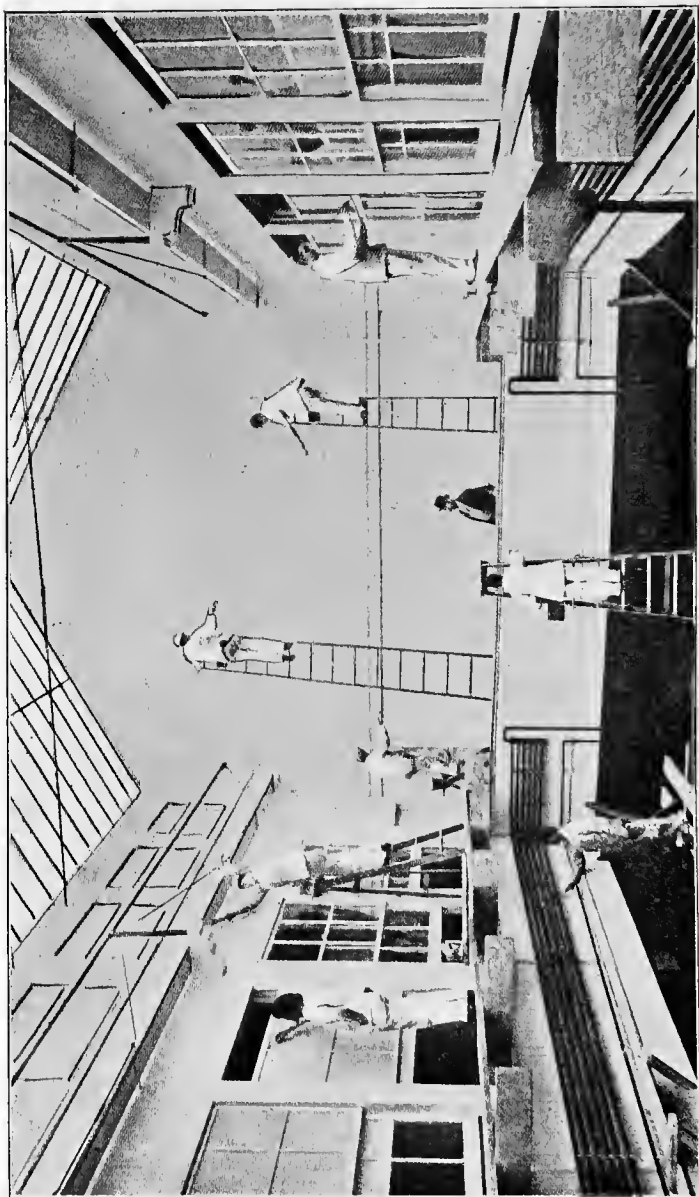
"It may seem strange that I have not mentioned English in my outline of the course of study for the two-year secondary technical school, but I have not intended that it should be omitted from the course by any means. In both years there would be required, as a part of the laboratory work, a great number of written reports, besides considerable written work in mathematics and other class-room subjects, and from time to time more extended reports from current periodicals on assigned topics. All of these reports would be carefully criticised for expression, style, and good English, as well as for subject-matter, the idea being that the best way to learn English is to write it continually, and write on a subject with which one is familiar. These criticisms offer the best kind of instruction.

"The following table shows more clearly than I can describe in words, perhaps, just what the proposed two-year course for the secondary technical school would contain, and I have chosen for my unit of comparison the credit hour, which corresponds to one recitation or two hours of laboratory or drawing per week for one term (one-third of the school year). In order that we may better understand the meaning of these figures, I have made comparison with the courses in mechanical engineering in the country, and I have chosen the Massachusetts Institute of Technology and the Ohio State University as institutions having representative courses in different parts of the country:—

—	Secondary Technical School.	M.E. Course, M.I.T.	M.E. Course, O.S.U.
Drawing, ...	30 Ord. hrs.	37·5 Ord. hrs.	23 Ord. hrs.
Shopwork, ...	30 "	22·5 "	22 "
Mathematics, ...	30 "	24 "	31 "
Physics, ...	15 "	18·5 "	9 "
Physical Laboratory, ...	12 "	3 "	4 "
Mechanics, &c., ...	15 "	54 "	68 "
Language and other subjects not included in above.	—	70·5 "	48 "



Plumbing Department.—New York Trade School.



House Painting Department.—New York Trade School.

"The comparison shows that the secondary technical school would have about the same amount of mechanical drawing and machine design as the engineering courses, and considerably more shop-work. It would have the same amount of mathematics, but, of course, of lower grade, but more physics and physical laboratory. It would have only one quarter as much time devoted to mechanism, mechanics, and other theoretical branches, but it would have as much time devoted to mechanical laboratory. No time would be available for languages, literature, political science, or other similar subjects.

"It will be noted that the total of time for the two-year course is more than half the total of either of the four-year courses, and it would appear that too much had been crowded into the shorter course. The difficulty arises, however, from the fact that there is so much larger a proportion of shop-work, laboratory, and drawing-room work in the shorter course—two hours of which not being the full equivalent of one hour of class-room work in a technical subject—that it appears more difficult, when in reality it is not."

There is no day course in chemistry at the Pratt Institute.

Chemistry. The evening course, however, deserves mention both for its intrinsic interest and for the evidence it affords as to the ideas which govern the Institute. The course extends over three years :—

First Year.—Principles of general chemistry and of chemical combinations, properties of the non-metallic and metallic elements and their compounds.

Second Year.—Qualitative analysis; the separation and determination of the various metals and acids in solution and in solids.

Third Year.—Quantitative analysis by weight and by volume; elements of assaying.

Lectures and laboratory work, throughout the three years.
An evening certificate is granted upon successful completion of this course.

The subject-matter, on which the teaching of principles is based, is such as would interest students from "works"—a plan which, on this side, has been in successful operation at the evening classes in chemistry of Finsbury Technical College (London) for many years. In the first year's class (evening course) there were found twenty-eight students; in the second year's class, twenty-two, who had already done the first year's work; and in the third twenty, who had completed the work of the previous two; and the regularity of attendance was excellent. I verified the facts. The explanation offered for such a remarkable attendance at evening classes was :—

- (a.) The practical character of the instruction;
- (b.) The fact that men holding the three years' evening certificate readily secured promotion in their own works or obtained higher posts elsewhere.

The character of the instruction may be somewhat gauged by the fact that while the head teacher of the department had

the ordinary doctorate course in chemistry, including one year at Zurich, one of his assistants was superintendent of a glycerine factory and the other was a foreman in the Government Laboratory, Naval Yard, New York—a combination of talents and experience that generally succeeds. It may not be out of place to refer here to somewhat similar figures of classes (evening) in chemistry at the Cooper Institute. There the chemical department is large and very active; the course—a five years' one—consists of general chemistry and qualitative and quantitative analysis leading into manufacturing chemistry. Fifty per cent. of all the students work through the full five years' course—ten hours per week of thirty-four weeks per year. At the first year's work I found thirty-seven students; at the second, nineteen; at the third, twenty-two; at the fourth, twenty. The fifth year figures were not noted. The eagerness of the students of all years was an excellent feature. As a rule, they were in shirt sleeves; many had also removed their waistcoats. This institute grants a B.Sc. degree to every student who successfully completes the five years' course.

As regards the success of the Pratt students, I was told that

**Employment for
Students.**

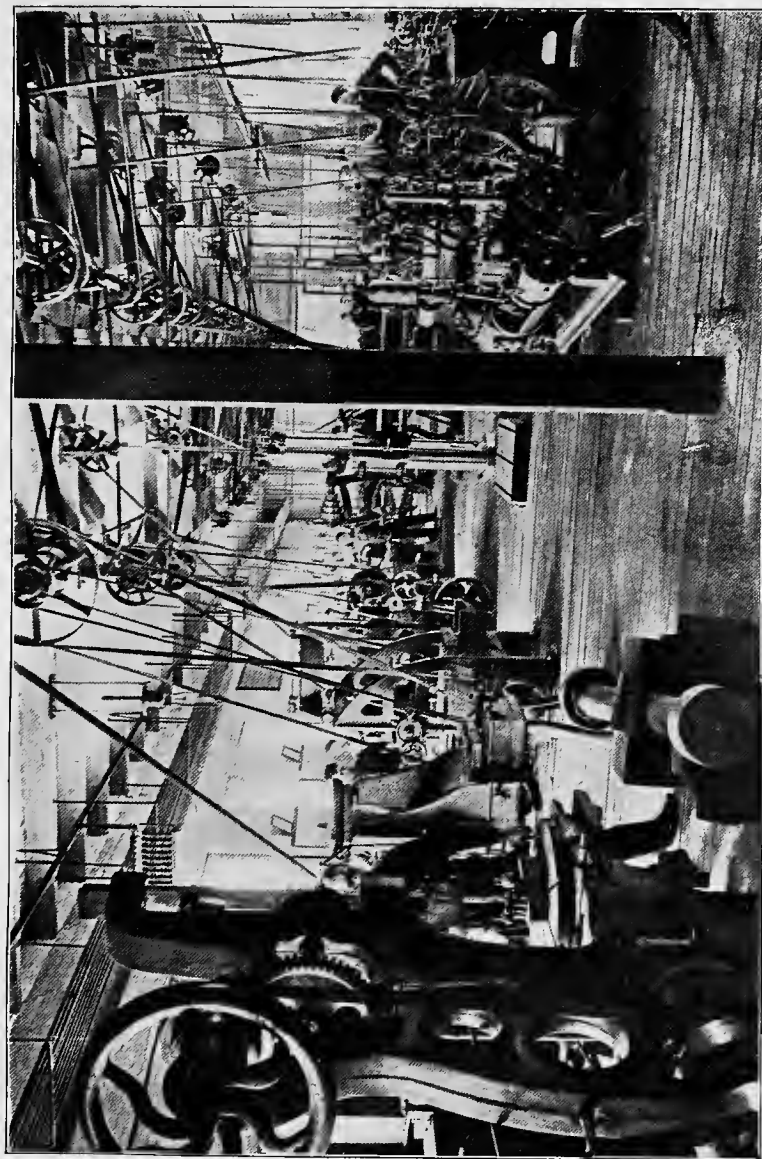
those who complete the courses secure employment immediately. At the close of the session 1901-2, each of the fifty-one day graduates (students who have completed the course) obtained satisfactory employment in a line of work for which he had been preparing. In the spring of 1903 the superintendent of the Edison Electric Lighting Company visited the Institute, and on seeing the second year electrical engineering class at work offered to engage all the students at the close of the session. Statements to this effect may seem somewhat "tall"; but they are borne out by the long list of former students, with present employment given, to be found at page 158 of the *Pratt Institute Monthly* for April, 1903.

Success has been found to depend on close contact with industrial work; it has taken the Pratt Institute sixteen years to establish the connection now formed; and the result is seen in a full complement of students and a long waiting (for admission) list. Instances of Secondary Technical Institutes need not be multiplied. There are many of them in the States. I have outlined what appeared to me to be the leading features of one of the best of them.

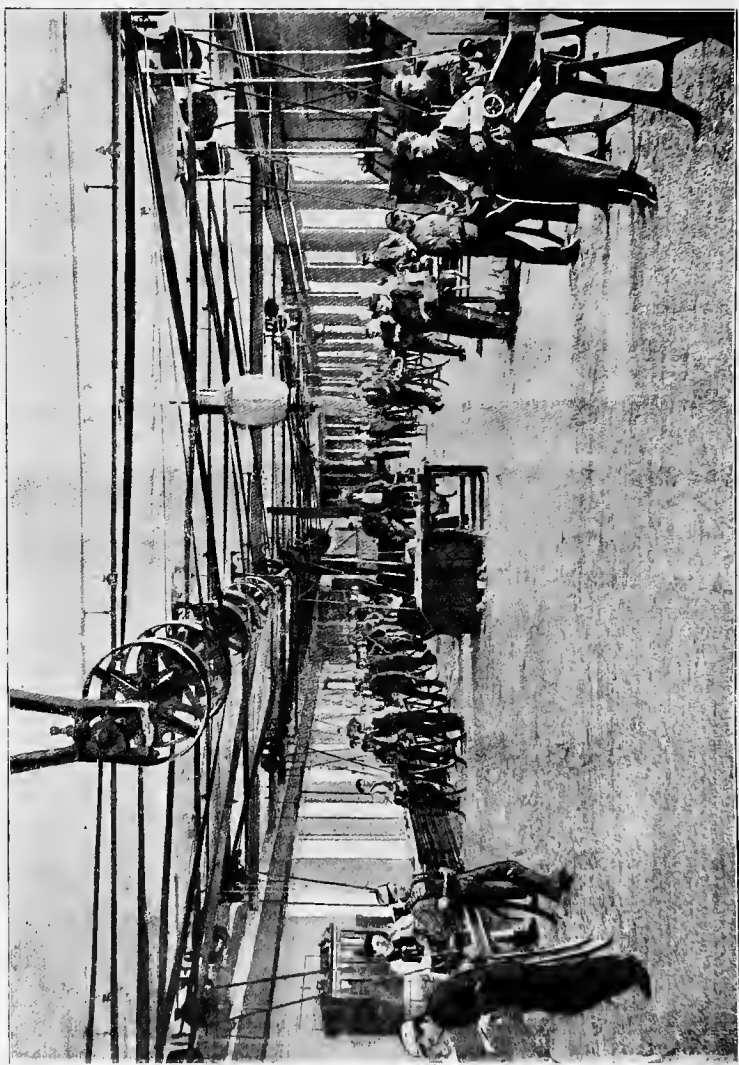
These divisions of labour and function, i.e., the work of the trade school and of the secondary technical institute, are parallel to some of the changes that have occurred in machine shops; and they are succeeding, and will succeed, so far as they maintain the paral-

**Effect of Machinery
In the Shops.**

lelism. Machine tenders are no longer being taken from the ranks of mechanics, but from the ranks of labourers; and



Machine Shop.—Sibley College, Cornell University.



Wood Shop.—Sibley College, Cornell University.

mechanics are being elevated to tool builders and tool designers. Each class is being advanced and made more productive, and each shares in the general advancement.

Sibley College, Cornell, and "Boston Tec." may be taken as the leading examples of institutions of the front rank—those which prepare the "Captains of Industry." Let us examine a few of the features of each.

Candidates for admission to Cornell must be at least sixteen years of age, and must present an accredited high school certificate, the certificate of the College Entrance Examination Board, or submit to an examination. This examination varies according to the department of the university which a student intends to enter. Candidates for the course leading to the degree in mechanical engineering (including electrical engineering, marine construction, and railway mechanical engineering), must offer English history, plane geometry, elementary algebra, solid geometry, advanced algebra, plane and spherical trigonometry, advanced German, and advanced French.

An equivalent of any two of the following entrance subjects or groups of subjects (*a—k*) may be offered in place of either advanced French or advanced German, for entrants to the course of study in mechanical engineering. Advanced Spanish counts as two of the equivalent subjects below :—(*a*) Elementary Spanish ; (*b*) Latin Grammar and Cæsar ; (*c*) Latin Composition and Cicero ; (*d*) Virgil ; (*e*) Greek Grammar and Xenophon ; (*f*) Greek Composition and Homer ; (*g*) Physics ; (*h*) Chemistry ; (*i*) Geology ; (*j*) Botany ; (*k*) Drawing.

The standard of attainment demanded is that the languages, mathematics, and science, which any student presents for admission to the university, should in every case be the maximum which the better class of high schools and academies are qualified to furnish. Students of advanced standing from other universities and colleges are admitted on certain conditions.

The total yearly expenses of students may vary from £60 to £100. Financial assistance is offered in the form of a large number of State (New York) and university scholarships and fellowships. Many students support themselves in whole or part by their labour in attending to furnaces, waiting at table, typewriting, and such other work as they can secure at the university or in the city of Ithaca. The State scholarships are awarded on the result of a competitive examination in English history, plane geometry, algebra, and any two of Greek, Latin, French, German, and advanced mathematics. In lieu of advanced mathematics a candidate may offer physics, chemistry, botany, geology, or zoology.

A State scholarship entitles the holder to free tuition (value £25) for each of four years. The scholarships take the place of a free university for New York State; 150 are annually awarded, and at any time there may be 600 State scholars in Cornell. Eighteen university scholarships, of the annual value of £40 for two years, are also awarded to entrants.

The courses for a degree cover four years in the Colleges of

- (a.) Arts and science ;
- (b.) Law ;
- (c.) Medicine ;
- (d.) Veterinary science ;
- (e.) Agriculture ;
- (f.) Architecture ;
- (g.) Civil engineering ;
- (h.) Sibley College of Mechanical Engineering and Mechanic Arts.

It is not worth while giving details of the organisation and equipment; it will be taken for granted that an American institution does not lack for equipment, though, strangely enough, Cornell does; and in view of the constantly increasing number of students, the late director, Mr. R. H. Thurston, was constantly urging "the need of a larger staff, a larger equipment, new organisations of laboratories, and new schools of engineering, and most of all, an assured and increasing income." The blacksmith's shop was particularly interesting. Fifty students were at work; their overalls being sometimes of the scantiest. A story is told of a Chicago lady who, while visiting Cornell University, found her grandson at work over a forge. A look of dismay covered her face: "Why, John, your grandfather started as a blacksmith." "It turned out pretty well," replied the student, "since it made the 'governor' a millionaire!" "Yes; but he did not have to go to college to learn the trade," she continued, shaking her head; "he got 7 dollars a week from the start, and here you are paying out 25 dollars a week to stay here. I must speak to your father about it."

It is said that the student did not endeavour to explain the "new apprenticeship."*

The conditions regulating admission to courses and graduation at the "Boston Tec." differ in some material respects from those of Cornell.

Applicants for admission are required, as a rule, to pass an entrance examination; though exception is made in the case of those presenting satisfactory certificates from the College Entrance Examination Board, or those who have passed entrance examinations at another college. In the case of persons who are past the usual student age, or who have

been engaged in teaching or in technical pursuits, admission may be granted, at the discretion of the faculty, without examination.

No school certificates are accepted : a somewhat unusual, if not quite exceptional, rule.

Obligatory subjects for admission are :—

Algebra,		French,
Plane Geometry,		Geometry,
Solid Geometry,		English,
	History.	

The Electives, of which one must be chosen, are :—

French (additional) or German.
 Latin,
 English (additional),
 History (additional),
 Physics,
 Chemistry,
 Mechanical Drawing and Mechanic Arts (Manual Instruction).

Note.—Physics will be transferred to the obligatory list in 1905 and thereafter.

The statistics of admission in 1902-3 may be interesting.

Of the 1,608 students of that year, 659 were not connected with the school in 1901-2. Of these, 408 were admitted as regular students of the first year, upon the basis of their entrance examinations. The 251 remaining, comprise (1) those who had previously been connected with the institute, and have resumed their places; (2) those who were admitted provisionally without examination; (3) those who were admitted by examination as regular second-year or as special students; (4) those who were admitted on the presentation of diplomas or certificates from other institutions of college grade or from the College Examination Board. In addition to the 408 who were thus admitted to the first year on examination, and have taken their place in the school, 70 were admitted on examination, but have not entered the school.

In the case of the 408 persons who were admitted on examination and have joined the school, the results of the examinations, embracing both those of June and those of September, were as follows :—

Admitted clear,	.	.	.	316
„ on one condition,*	.	.	.	75
„ on two conditions,	.	.	.	17
				408

One hundred and four applicants were rejected. Fees, £50 a year.

* A condition means that there was failure in some subject of examination.

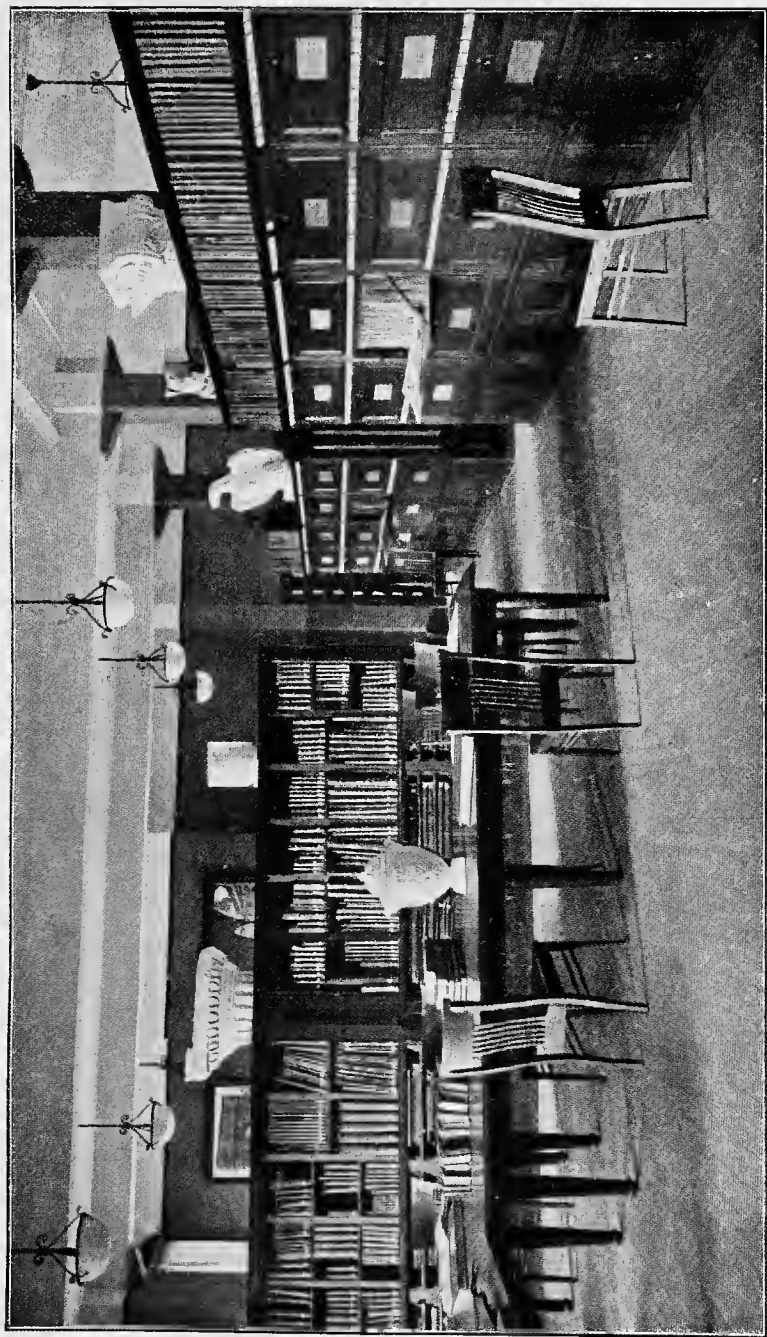
Forty scholarships are given by the State (Massachusetts), and where capacity and need are shown a considerable number of scholarships is awarded by the Institute. These scholarships are not in any sense awarded as the result of a competitive examination. Capacity has to be shown by the first year's work; the need is most strictly investigated. Application is made on a form, on which the names of referees are given. These are privately communicated with; and the student's financial position is closely inquired into by two members of the staff. The case is finally presented to the Faculty for consideration and decision. The minimum yearly funds required by a student to provide fees, board and lodging, and all other necessities, are £130. There are thirteen possible undergraduate courses, each of four years' duration.

- I. Civil Engineering.
- II. Mechanical Engineering.
- III. Mining Engineering and Metallurgy.
- IV. Architecture.
- V. Chemistry.
- VI. Electrical Engineering.

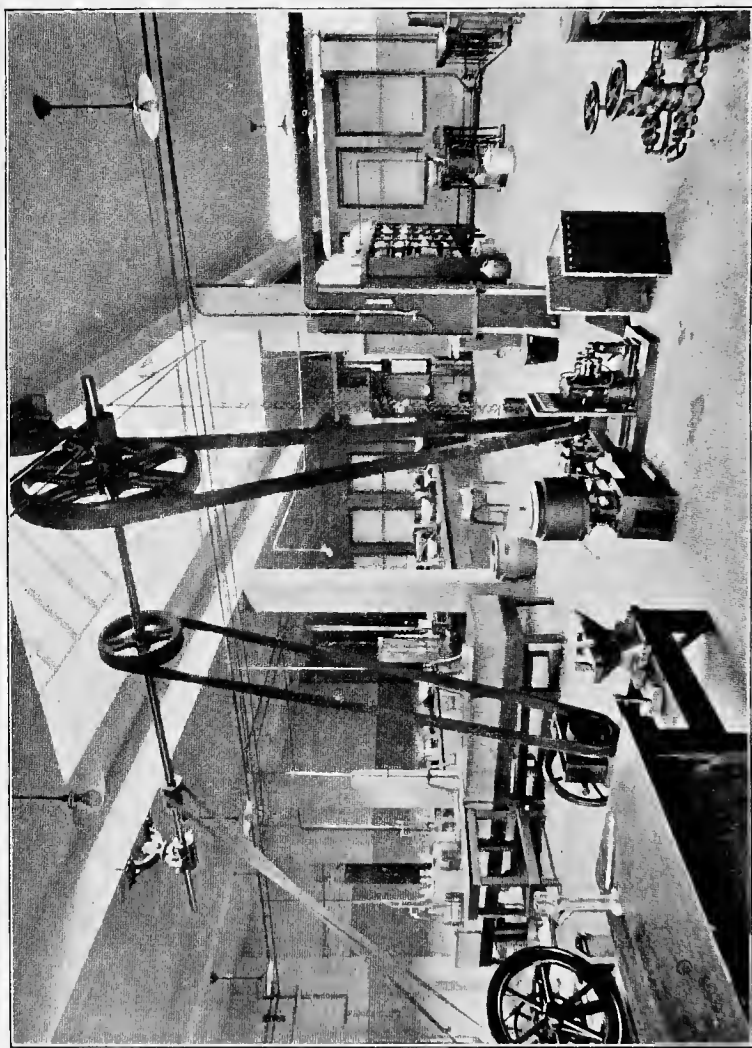
- VII. Biology.
- VIII. Physics.
- IX. General Studies.
- X. Chemical Engineering.
- XI. Sanitary Engineering.
- XII. Geology.
- XIII. Naval Architecture.

The time-table of the first year's work, and especially that of the first term, is very interesting, because of its general character. It was explained to me that the whole staff was agreed as to the need of an advanced general education (see entrance requirements) as a basis for their specialised instruction; and it was contended that while no complaint was made as to the teaching of literary and linguistic subjects in high schools, the mind of a youth who had committed his education to the institution was in a more mature and receptive condition for further literary, linguistic, and economic teaching. In this connection the prescribed summer holiday reading of English classics also deserves mention. (See Appendices, p. 132.) There is a strong inclination on the part of some of the "Boston Tec." staff to strengthen the first year's general course; and, if necessary, to make the course of studies for a degree a five year one. In this connection, the following quotation from the Annual Catalogue (*i.e.*, Prospectus) of the Institute is very interesting:—

"The student purposing to enter the Institute should bear in mind that the broader his intellectual training in any direction, and the more extensive his general acquirements, the greater will be the advantages he may expect to gain. The importance of thorough preparation in the subjects set for examination is also great; for the character and the amount of instruction given in the Institute from the outset leave little opportunity for one imperfectly fitted to make up deficiencies, and render it impossible for him to derive the full benefit from his course, or perhaps even to maintain his standing. The training given in the best high schools, manual training high schools and academies will, in general, afford suitable preparation.



An Alcove in the Architectural Library.—Massachusetts Institute of Technology.



Laboratory of Industrial Chemistry.—Massachusetts Institute of Technology.

"The requirements of age and scholarship specified are regarded as a minimum in all ordinary cases, and only exceptional circumstances will justify any relaxation. Parents and guardians are advised that it is generally for the ultimate advantage of the students not to enter under the age of eighteen years, unless in the five-year course."

Laboratories and staff are large; but the large number of students in attendance (1,600) is a subject of great anxiety. Like Cornell, the institute has, owing to its success, reached a critical period in its history, and new developments may be expected.

For the sake of comparison with Cornell and Boston, I add a few similar features in respect of the University of Illinois*—an institution with over 4,000 students, 750 being in the engineering courses. The university of Illinois is a land grant and mechanic arts college, and a "free" university.

A schedule of expenses may explain what "free" means.

The following are (for students attending at Urbana) the estimated average annual expenses, exclusive of books, clothing, railroad fare, laboratory fees (if any), and small miscellaneous needs:—

Semester fees, ...	\$24.00 to \$24.00
Room rent for each student (two in room), ...	32.00 ,, 60.00
Table board in boarding-houses and clubs, ...	90.00 ,, 124.00
Washing, ...	18.00 ,, 24.00

\$164.00 to \$232.00

Board and room in private houses, per week, \$4.50 ,, \$6.00
i.e., £33 to £47 per annum. The tuition is practically free. Board and residence vary from £33 to £47 a year according to a student's tastes and ability to pay.

The university is situated at Champaign (Urbana), right out on the prairie, and the combined effect of the excellent weather and of the beautiful surroundings on the day of visit, induced a desire to see all universities, colleges, and schools placed in the country.

There are processes at work which lift such a desire out of the list of those of unattainable objects. Just as in the remote rural districts, a process of consolidation is now going on; and as in many cities, there is a movement to pick the children out of the slums; so I think there is nothing bizarre in the suggestion that Americans will so improve the net-work of electric cars that they will one day take town children out to schools in the country.

The equipment of the technological department is excellent.

The numbers of day students in attendance at these technical institutions demonstrate a success beyond anything we know of in this country. The age and

Causes of Success. number of the students, their previous preparation, the four years' courses, and the number of graduates who remain to study, constitute a form of preparation for industrial work such as we know little of.

After two days in the Institute of Technology, and two evenings with some of the heads of departments, I was impressed with the view that the success of the Massachusetts Institute of Technology—and in varying, though less degree, that of other colleges or institutes of technology—is due to the following causes :—

1. Success ;
2. Hard work ;
3. Close touch with industries ;
4. Practical character of the instruction ;
5. The boldness of the students ;
6. Some minor causes.

1. There is little need to dwell long on the success of these institutions. Cornell and "Boston Tec." are known throughout the States and Europe as educational institutions of the front rank. Their students are not drawn merely from the State of New York or of Massachusetts. Forty-one states of the Union and one territory, besides the district of Columbia and Porto Rico, are represented on the list.

Success.

Of the total number of 1,608 in "Boston Tec," Massachusetts contributes 935, or 58 per cent. of the whole ; 164 are from other New England States ; 509 are from outside New England. Of these, 47 are from foreign countries. In a few cases they come from Great Britain, the British Colonies, and Japan. The fame of the institution is so great that the ablest boys in the States are attracted, and their present success is thus contributing to future greater success. (See Appendices, p. 92.)

2. The work on the part of the students is severe, and especially so in the case of those of the Massachusetts Institute, for the conditions of life in Boston do not lend themselves to the same amount of distraction as at Illinois or at Cornell, both of which are beautifully situated in the country, and have a corporate life of work, and social, athletic, and other clubs. The absence of social life is, on the whole, a disadvantage to "Boston Tec." and the staff are endeavouring to improve this side of the institution for educational as well as recreative purposes. Their graduates must be capable of holding their own anywhere, and this capacity requires a certain amount of social experience.

The absence of Social life.

Again, there is, in each institution, a considerable "mortality," or shedding of students. Some students find their general preparation insufficient ; some find the pace too great ; others find their funds give out ; and some are advised that they have made a bad selection. In such cases the American student accepts advice, and acts promptly. At every step a

student's work is known; and the faculty—staff of professors in each department—every four months discuss fully a student's work. The middle of the third year is the critical point in a student's career. At this stage the Institute requirements demand a final decision as to choice of work. Fifteen men in one department were, at this point, recently advised to change their courses or to withdraw from the Institute. I was informed that as a rule 25 per cent. of the civil engineering students drop off at the same stage. These numbers have to be added to those who have previously "fallen by the way."

The greatest patience is extended to the students, and the best advice is offered to them; but in the interest of the individual, as of the standing of the Institute, and of its influence on industrial work, such shedding of students is regarded as inevitable, and is acquiesced in. It does not follow that the men are "wasted." As a rule they find employment of a lower character than they were aiming at; they change the directions of their careers to their own great advantage; or they pursue a course of studies on the same lines at a secondary institution—a two-year course school.

3. There are 183 instructors on the permanent staff of the Boston institution. Without counting lecturers, the number of instructors to that of students bears the proportion of one to nine and seven-tenths. The following table shows the distribution among the several classes of instructors:—

	1901-2.	1902-3.
Professors, ...	29	28
Associate Professors, ...	9	12
Assistant Professors, ...	25	25
Instructors, ...	50	54
Assistants, ...	36	46
Lecturers, ...	40	18
Total, ...	189	183

The salaries of junior instructors vary from about £100 upwards to £200 or so; assistant professors, £400-£500; and professors, £500-£700. The distribution of salary-fund over a large number of comparatively young men, rather than the purchase of a great name at a great price, has the advantage of distributing work in such a way that each man is a specialist, and the faculty in conference all-wise. The salaries, however, are not large enough, compared with those offered in "works," and the Institute is constantly losing good men. On the whole, the staff consists of young men; academic traditions are consequently not too strong. As a rule, the

**The Staff and
Consulting Practice.**

heads of departments and their "seconds" are permitted to engage in consulting practice. This holds true generally of technological institutions. Occasionally in such institutions this permission is abused, and the authority of the president has to be

exercised ; but the arrangement as a rule works well, and it is regarded as essential to a professor's vitality, and a necessary and preliminary condition to the success of his teaching. Such an arrangement also brings a welcome addition to his income, and thus induces him to remain at the institution. At Boston one member of the staff of the Department of Chemistry is engaged three days a week in a research laboratory in "works"; the other three he devotes to instruction at the institution. In his department at the Institute seven or eight graduate students (working for a higher degree) were engaged on the same researches as the professor's mind was exercised on at the "works." There were some differences in the presentation and methods of attack, but the problems were essentially the same. Such close alliance with works is regarded as good for the works and good for the students. The department of electrical engineering at "Boston Tec." was recently separated from that of physics, and the new head, Dr. Louis Duncan, sometime Professor of Electrical Engineering in Johns Hopkins University at Baltimore, had for a few years past been engaged as a practising engineer in New York city. Dr. Duncan retains his office in New York, and works half his time there.

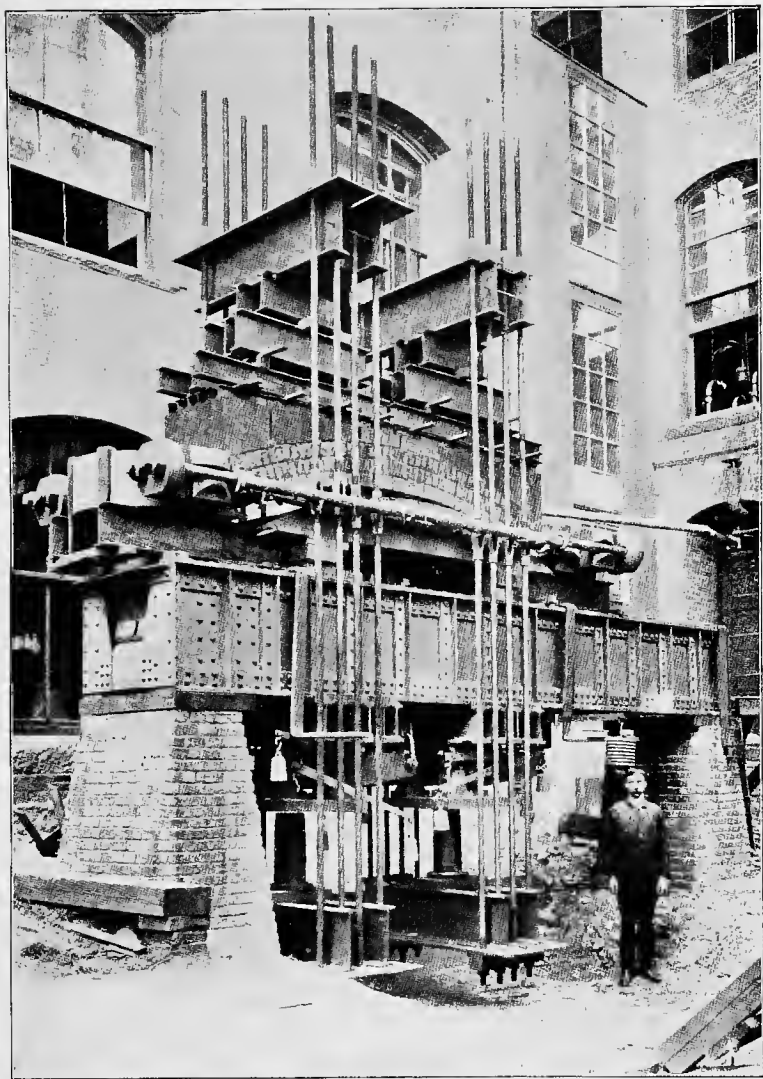
Another head of a department had fifteen years' experience as a bridge engineer, and is a member of the Massachusetts Railroad Commission (equivalent in some respects to the Railway Department of our Board of Trade), and other corporations. The head of the department of industrial chemistry is partner in a firm of consulting and manufacturing chemists. These are but typical examples.

Again, the *alumni* of the institute who have established positions for themselves in the industrial world, and heads of great firms or departments of firms, are easily induced to give series of lectures on special subjects on which they are experts. It is considered a special honour to receive such an invitation, and the work is, as a rule, done without a fee. In this way the Institute knows what industry is doing and what it requires.

4. In this way, too, a wholesome influence is extended over the instruction, and the kind and scale of exercises become just such as would prepare a man with some confidence of fitness to tackle industrial problems. Let us look

**Character of the
Instruction.**

at a few types. In the department of industrial chemistry one finds among the earliest exercises of the under graduates such an exercise as :—Take 3 lbs. of Turk's Island salt ; purify ; find the percentage of sodium chloride ; discuss the treatment of the filtrate ; write up the methods of procedure, and prices of plant required to deal with the problem on a commercial scale, taking into consideration labour and interest on capital, and so on.



Machine for Testing Full-size Masonry Arches.—Massachusetts Institute of Technology.



Machine Shop.—Sibley College, Cornell University.

Later, the students had to prepare a complete technical report on some manufacturing problem involving preparation of plans of plant, &c. A model report was given to each student as a guide. Such an exercise immediately precedes the thesis for a degree.

In physical chemistry the graduates were at work on such problems as :—

- (1.) An investigation of the properties of a new material for the candles of Arc lamps.
- (2.) An investigation of the manufacture of incandescent filaments from a new material.
- (3.) Investigation of insulating material.
- (4.) Investigation of the uses of porcelain in the form of resistance rods.

In civil engineering a year's work for an undergraduate would involve :—

- (1.) Design for a plate girder bridge, 60 ft. by 80 ft. span ; complete working drawings to be made.
- (2.) Design for a wooden bridge or wooden roof truss : complete working drawings to be made.
- (3.) Design a typical American pin truss railway bridge, 150 ft. span ; complete working drawings to be made.

The student, under direction, of course, makes all his own calculations.

- (4.) Thesis.

Lectures, discussions, criticisms, are frequent at every stage of the work. A student thus trained is competent to figure out the stresses and to design a bridge ; but he is not familiar enough with the details to enable him to put them together in the best way. This knowledge comes by experience only.

A valuable addition has been made to the apparatus of the mechanical laboratories at "Boston Tec." in the form of a gift from the Westinghouse Air-Brake Company of an entire air-brake equipment for a freight train consisting of a locomotive and twenty-five cars. This makes it possible to investigate practical and important questions concerning the working of air brakes. The boiler tests in this institution are never of less duration than twenty-four hours long ; and frequently they are continued over a week, night and day ; students taking the day and night shifts in relays. The tests, it is maintained, must be on a commercial scale ; it is argued that no other scale gives a sufficient guarantee of accuracy for commercial purposes.

In connection with railway engineering, the railway companies co-operate with both Cornell and "Boston Tec." in making provision for tests on a large scale. For example, some of the Boston thesis work has been done on the New York, New Haven, and Hartford Railway ; and the following quotation from the report of the Director of Sibley College, Cornell,

for 1902-3, illustrates in somewhat striking form the kind of work undertaken by students :—

“The Lackawanna Railroad Company has, as usual, given this department helpful aid in its work, furnishing engines and permitting their attachment to any desired trains on that road between Ithaca and Owego for the purpose of giving practical instruction, training, and experience to students. The work is performed under the supervision of the head of the department by seniors as leaders and juniors as assistants, and proves most profitable to all, while it is also an important element of the success of the school through its influence upon the officers of the railways. It shows the quality and competence of the sort of young man turned out by the school. Somewhat similar work, in the preparation for written theses, has been done by members of the senior and graduate classes on railroads at a distance, and entirely independently, with great success. In one case the work was performed on the Baltimore and Ohio Railroad, the train at times making eighty-five and ninety miles an hour, probably the highest speed at which experimental investigation of train performance was ever undertaken.”

In this connection it may be well to refer to the seminar meetings in the department of physical chemistry at the Massachusetts Institute. On my arrival in this department on the morning of my second day, I entered a room where a class appeared to be at work. I sat down and listened for a time to a discussion, which closed in about ten minutes. I was surprised to find two of the professors I was looking for, and to be introduced to other members of the staff. There were seven students and five members of the staff present. They had been discussing a problem of physico-chemical interest; and I learned that meetings for discussion of researches in progress and of published articles were held at least weekly. At such meetings the whole of the staff and the research students are present; each contributes to the discussion, and frequently in this way a student who has, so to say, got into a *cul-de-sac* in his experimental work, is shown the way out. Discussion, criticisms, and the insight and different view-point of new minds must be of great advantage to a student in his research.

A thesis always precedes a degree. Some professors assign these with more freedom for the student than others; but as a rule it is considered advisable not to put too big a burden on the student's back. As a matter of fact, in most cases the man is known long before he reaches his thesis, which is understood as merely lending him the last helping hand to stand and work alone.

In every department of the institute there is a workshop and also a departmental library. The value of the latter cannot be over-estimated. As, however, its success depends so much on the departmental librarian, I have no hesitation in quoting Dr. G. Stanley Hall on the ideal departmental librarian. He is

referring to the librarian of a department of educational psychology, but the "point" of the quotation is general.

"Having once settled thus each to the work which he seems able to do best, the problem of books and apparatus must be disposed of. The Librarian with ample funds carefully selects from all accessible sources the title of every book or pamphlet likely to be of service to each man, and most of the library fund is reserved for such expenditure. Here the work of the librarian becomes all-important, and is utterly different from that of any kind of public or other librarian. He must be familiar with all the year books and bibliographies, publishers' announcements, etc., and prompt to get in his orders. He must communicate with other libraries, and be as eager to do as to receive favours. He generally finds many otherwise unknown references, and is always running down new material, and bringing forward weekly, if not daily, to almost all something each is glad to get. He is thus a diligent waterer, or the aquarius of the university garden, and on his efficiency very much depends. His work is not merely to produce speedily what is wanted, but to find out himself in advance what is serviceable. Unlike a public librarian, he has at hand catalogues not merely of books, but memoirs, in many archives—quarterly, monthly, or other occasional publications—so that he can tell at a glance, if he knows either author or subject, the whether and what of the many serial studies, archives, proceedings, and other special monographic literature. He even provides one or two hundred reprints of all the more important theses and articles published at his own institution in order to utilise them as exchanges for other special matter of similar kind, otherwise unattainable. He is himself a living index of indexes, not so much a bibliophile as a worker, holding books to be not ends but means, or best treated when soonest worn out in the service of those most competent. His pride is not in the order, number, or small loss list, but rather in the ratio of annual use, or the total number of books per person drawing them. He realises that the library must be a servant and not a master, and that the ideal is to make everything as accessible and tempting as possible."

5. A word is necessary on the boldness and character of many students at American colleges and universities. Cases of this kind mentioned
- The Grit of the Students.** are numerous, but they do not form a large percentage of the whole number of stu-

dents; they are in sufficient number, however, to show the grit of many of the young men, and the existence of such cases shows up a side of the University character which is long since dead in England, and which I fear is dying in Scotland, where it was somewhat common twenty or thirty years ago. Men maintain themselves by wages received for tutoring for clerical work, for waiting at table, for librarian work, tending furnaces and lawns, acting as tram conductors, lighting street lamps, carrying newspapers, canvassing for city telephones, city directories, or for political campaigns, &c. I saw one student acting as "washer-up" for two coloured purveyors of lunch, and was informed that his remuneration consisted of his meals. Another case was described to me of three University students who "ran" a laundry, themselves doing the work of collecting the clothes, and of washing, ironing, and redistributing the clean linen. Students, when they have settled their careers in their own minds and have definitely fixed their aims, will borrow a large part of the necessary funds with the utmost confidence in

their capacity to repay within a reasonable time. Such students are the very salt of the earth, and the nation is robust in health which rears such virile spirits. Their existence is creditable to the national character. Americans respect all who can work, no matter what the character of the work; and they have the utmost contempt for the idle and disregard of what is to become of them. Work or starve is a fundamental article of the American creed.

6. In a minor degree the success of these technological institutes is due to the absence of prizes and of "ranking." Their catalogues do not contain the lists of prize and scholarship winners, and merit lists are not to be found on the notice boards. At Cornell, a student may privately ascertain what his marks in any examination are. At "Boston Tec." a student never knows his marks. There are no honours degrees. The rivalry of students is, therefore, of a somewhat healthy character. What then are the incentives to hard study? First, though most remote, the great prizes in the industrial world; secondly, and intimately connected with the first, the young American sees he cannot afford to waste his time; thirdly, the fact that the faculty have it in their power to recommend into a good industrial firm. At Boston, the managers of firms appear a month before graduation "size up" and pick off the best of the students; and in Boston, as almost everywhere, there is a faculty Committee, which has charge of appointments.

The separation of functions and division of labour characteristic of the technical schools is exemplified in the institutions which prepare for the commercial world.

In the first place we have the schools which provide instruction in the subordinate mechanical processes of an office—copying, filing, &c.—and which train the army of office auxiliaries—stenographers, typists, and so on. Evening Commercial Schools and the lower type of business schools are good examples.

Next we have the schools in which the production of technical skill is still the predominant feature, but to which a considerable degree of general education is

Schools of Commerce. added. The more liberal training is included to enable the operations to be carried out more intelligently, and, in consequence, with greater economy of time. The Drexel Institute has a two years' day course of this character; the institute, in this respect, aims at preparing women (and occasionally men) to become secretaries to lawyers, judges, physicians, and other professional men. Students with a more liberal training are quick to appreciate technical terms; they can re-phrase a sentence; they can punctuate and paragraph correctly; they can also keep accounts, look up references, and collect information without detailed instructions. These schools stand, as it were, between Pitman's shorthand schools and the University.

Comparable to the institutes of technology are the University "Schools of commerce"—the Wharton School of Commerce in the University of Pennsylvania, being an excellent example. The object of such Schools of Commerce is well set forth in the two following quotations from "Lectures on Commerce," by H. R. Hatfield, of Chicago University :—

"While a school of mechanical engineering is required to fit a man for the practical parts of railroading, there exists in that profession a far more important career for the man who is competent to direct the traffic, classify goods, fix rates, watch the coming financial depression, know the signs of coming prosperity, have insight into, as well as experience with the questions of labour and the relations of employers to employes, understand the duties as well as the privileges of corporations, and who has the masterly mind to devise and carry out great financial operations involved in the management of securities on a scale hitherto unprecedented."

"To take another illustration.—A preparation for banking should not be a drill in technical book-keeping, or teaching a messenger how to carry a bag of gold in safety from one institution to another. The essential purpose of education leading up to such a profession would be a training in the principles affecting the problems which necessarily arise in local, national, and international banking. There are principles of money and credit underlying these phenomena often not understood even by many bank officials. The man who has been taught how to approach such problems, to work out solutions, to apply power and grasp of large and important subjects, must, in the end, prove an infinitely better head of a bank than he who has come slowly forward from the window of an accountant or teller, and whose professional education has consisted of the chance events brought to his attention in the round of daily business. Men of this latter description will become accurate, steady, and useful to the institution in minor positions ; but if promoted to high posts they will be found to know really nothing beyond the dry husks of their professional experience or a personal acquaintance with their constituency. The recruiting of high officials in this fashion accounts for the prevalence of so much lagging conservatism and ignorant timidity in regard to burning monetary questions of the day."

The Wharton School has 250 students ; the course for graduation involves four years' study in commerce, political economy, finance, and political science. Just as industries are looking to the institutes of technology for the engineer, the architect, and the chemist, so commerce is beginning to look to schools like Wharton for the material out of which the great managers are made. Similarly, too, professors in schools of commerce are allowed to practice : Dr. Emery R. Johnson, of the Wharton School, acted as one of the United States Commissioners who inquired into the Panama Canal question. He also codified the laws of Porto Rico.

CHAPTER V.

THE RELATION OF TECHNICAL EDUCATION TO INDUSTRY AND
COMMERCE IN THE UNITED STATES.

It would be no exaggeration to say that the governing idea which led to the formation of a Commission to undertake an inquiry into American education, was the belief that the Commission would demonstrate that the industry and commerce of the United States are superior to British industries because British public education is inferior to American public education.

**Objects of the
Commission.**

The general effect of my visit has been to confirm what I think is the common view, that the American school system, past and present, has not been a large determining factor in the success of American industries and commerce. Such success was due in the first place to the virile and enterprising character of the American people—characteristics not developed by education in the narrow sense of the schools, but by education in the wider sense of the effect on the American people of two centuries of pioneering in a vast and rich, but undeveloped though not uninhabited, continent; in the second place, as in the United Kingdom and in Germany, to great individuals—Carnegies, Whitworths, Krupps; and in the third place, to the constant contribution to the citizenship of the United States during the middle half of the nineteenth century, of much excellent human material from the United Kingdom, and in a less degree from the other countries of Europe.

But the visit has also produced a strong impression that the future industries and commerce of America are being directly and profoundly affected by the schools of to-day.

The last quarter of a century has witnessed everywhere a general process of aggregation in trades, businesses, and industries.

The area of operations of these centripetal economic forces is larger in the United States than anywhere else; and it is believed that the only limit to aggregation is the want of men capable of managing the resulting combinations. Further, in addition to the need

**Economic Forces
Demanding Industrial
Cadets.**

of capable managers of these organisations, the scale of their operations has often demanded their direction from a distance through subordinates; and that too, not only on the result of personal observation, but on evidence supplied by reports of subordinates. Able lieutenants have become essential. Urged on by the necessity for quick multiplication of such officers, and

guided by the instinctive boldness of Americans in trying new methods, the great industrial and commercial firms are abandoning the traditional methods of waiting for apprentices to "come through," and are attempting to manufacture the junior officers, by a rapid process, out of college graduates in technology and commerce. Furthermore, the men who came through by the traditional slow process had plenty of will and forcefulness; but the play of forces on them, while emphasising these natural characteristics, did not, as a rule, provide sufficient opportunity for the development of intellect, grasp, judgment, ability to apply general principles to details. Such men could in fact apply rules, but not the principles on which the rules were founded.

Now the Americans have a way of regarding most things as machines, and they regard the "balanced and seasoned intellect" as a piece of delicate but most efficient mechanism. They look upon the schools as workshops where the faculties of the mind can have their qualities developed, and strengthened, and balanced, just as metals with different qualities—strength, tenacity, elasticity—can be produced from raw materials, the ores. Such a mechanical view of the mind has contributed materially to the American belief in education, and no section of the community has a greater belief in the value of education than the leaders of industry and commerce. These "captains" look to education to make the "cadets" who, with added experience in factory, field, or office, can be employed as designers, engineers, salesmen and buyers, managers of branches, men who can clearly and agreeably present the firm's views, and who have the ability to extend the firm's business—the trusted subalterns from whom later the "captain" will be chosen.

American experience favours the college-bred man for this purpose and for these posts. The sentiment is, however, not very old—ten years at least, twenty at most—and possibly was due originally to a few excellent college trained men who had "come through." One experienced leader was disposed to attribute the whole movement to a single Zurich polytechnic man.	College-bred Men as Industrial Cadets.
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Whatever the causes, the sentiment undoubtedly exists. Every institute or college of technology gives as an appendix to its report for a given academic year, a list of appointments held by its graduates. These take the place of our prize lists. Naturally. An opportunity in a good firm is the prize on which such men have set their hearts. The "Boston Tec." lists cover 100 closely printed pages, the list of the "1902" graduates alone occupying seven pages. Some of the lists have been analysed, and a few details from them pertinent to the subject under consideration may not be uninteresting.

At Cornell University, from the inception in 1868 until September, 1902, 598 students had graduated in civil engineering. An inquiry into their present occupations elicited returns which show :—

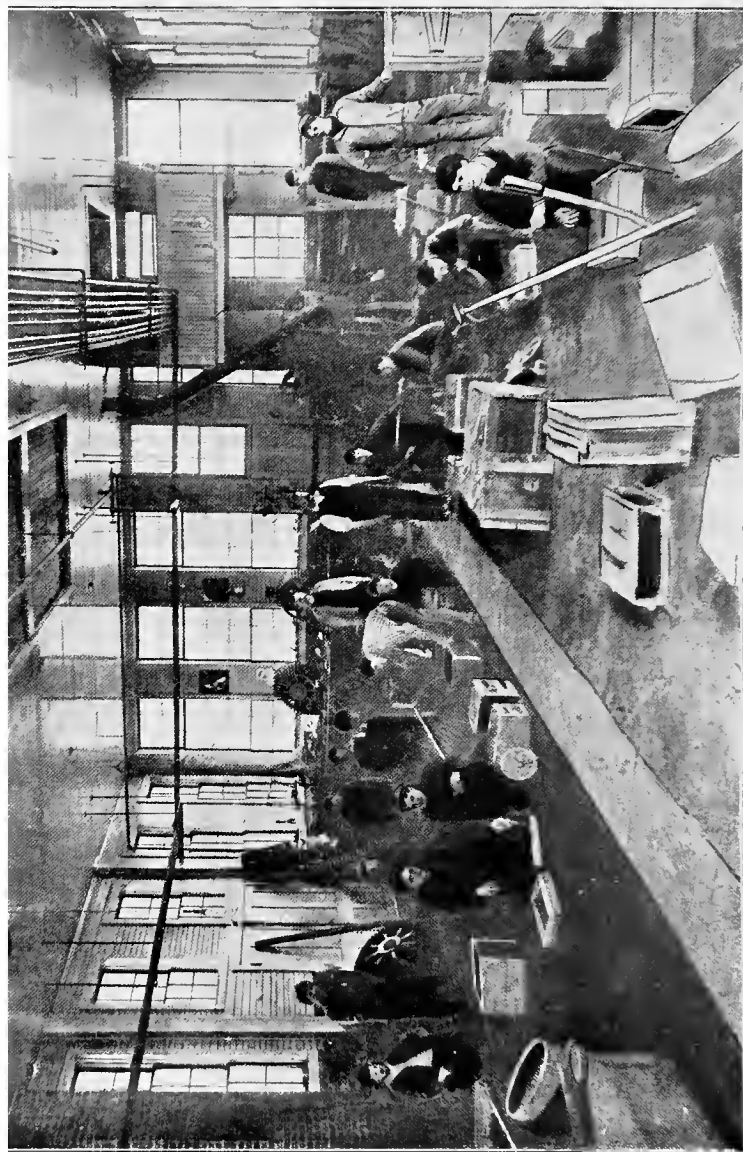
I. Presidents of industrial corporations, and managers, ...	16
II. Chief engineers, superintendents, and managers, ...	164
III. Assistant chiefs, resident and division engineers, ...	75
IV. Professors of universities, ...	40
V. Assistant engineers, ...	125
VI. Pursuing allied professions, ...	58
VII. Draughtsmen, ...	41
VIII. Miscellaneous business, ...	24
IX. Incomplete returns, ...	7
X. Deceased, ...	48
	598

The graduates of Sibley College (excluding Civil Engineering) number about 1,300 :—

“ Their average age, as *alumni*, is about seven years, *i.e.*, they have had, on the average, about seven years in which to establish themselves and make such advance as they have actually effected. The great mass of these *alumni* have left college since about 1890. Of these graduates, about 900 have reported their present positions and something of their history. The reports from the remainder are slowly coming in. Of these 900, about 250 are engaged in miscellaneous manufactures, 110 in electrical manufactures, 90 are teachers, 50 are in railway work, as many more in heat-engine construction, and others in heavy machinery construction and the steel manufacture in about equal numbers. Nearly 50 are contracting engineers, 65 in electric railway and electric light work, 35 in telegraph and telephone companies, 23 in consulting engineering and expert work, 31 in naval construction and engineering, and 15 in the supervision of engineering ‘plants.’ About 40 have gone into branches of business allied to mechanical engineering more or less closely, and the balance are engaged in a great variety of other vocations, mainly, however, professional. Very few have found it either necessary or desirable to abandon the profession. Of the total heard from, 10 are presidents of companies, and 500 and more are in positions of responsibility and control, exclusive of the *alumni* engaged in teaching. Of the latter, about two-thirds are professors or principals. There are eight *alumni* in the army and the navy and revenue marine, and 12 in the United States Patent Office. Of the 35 in the telephone business, 21 are engineers or superintendents. In the electrical manufactures, of the 111 reporting, 76 are in similarly responsible places. Of the 30 reporting from the ship-building establishments, practically all of whom are recently



Blacksmith and Forge Shop.—Sibley College, Cornell University.



Foundry — Siskiyew College, Cornell University

out of college, 6 are superintendents, general managers, proprietors, or engineers, having charge of work. The 44 men in the contracting business are, with the exception of four, all in responsible positions or are members of firms. Of the 250 in miscellaneous lines of business, over 180 are proprietors or officers of the establishments in which they are engaged. Of the 50 engaged in railway work, one-third are apprentices, one-third are responsible officers, usually 'mechanical engineers' of the corporations, and the balance are commonly designers and draughtsmen, and in positions offering good opportunities to learn the business and to advance. Of those engaged in engine building, two-thirds have positions of responsibility as superintendents, general managers, designing and construction engineers, &c. The remainder are usually designers and in line for rapid promotion. Those in the steel business are nearly all in positions of responsibility."

The "Boston Tec." lists have not been analysed, but it is possible in another way to give some idea

Boston Cadets.

of the success of their students from details collected from the men who formed the class of 1893—the class of only ten years ago. The class appears to have consisted of 300 students; 23 now deceased.

Of the total replies received, 185 reported their incomes. The total annual income of the 185 men who reported is £114,050, ranging in amounts from £100 to £7,120. Arranging the incomes in groups we get the following results:—

Incomes.	No.
Less than £200, ...	2
£200 and less than £300, ...	32
£300 " £400, ...	43
£400 " £500, ...	31
£500 " £600, ...	20
£600 " £700, ...	21
£700 " £800, ...	10
£800 " £900, ...	6
£900 " £1,000, ...	1
£1,000 " £1,200, ...	5
£1,200 " £1,400, ...	2
£1,400 " £1,600, ...	1
£1,600 " £1,800, ...	1
£1,800 " £2,000, ...	0
£2,000 or more, ...	10

185

The average annual income is £600. A figure which is perhaps more representative is £471, obtained by omitting the income of five figures in dollars, which are exceptionally large.

Of the total, 45 men receive incomes above the average £600, and 140 men below the average.

These figures emphasise the prospects of industrial cadets and their rapid promotion—features of the American industrial system which deserve much serious consideration.

As soon as I ascertained that such openings for college-bred students were common, I made an endeavour to gather views from the industrial as

**Views of Industrial
Leaders.**

distinguished from the educational institutions, and I interviewed the general superintendent of the Carnegie Steel Works, Pittsburg (not a college-bred man); a leading officer of the Westinghouse Electric and Manufacturing Co. (a "Boston Tec." man); Mr. Johnston, one of the partners in the Baldwin Locomotive Works; and others. At the same time, with the help of Sir Percy Sanderson, British Consul-General in New York, I was able to address inquiries to leading business men in the States. The results of such inquiries and interviews I have summarised below :—

In the Westinghouse shops and offices 160 college-bred men are engaged, out of a total of 10,000 employees. At the Carnegie Steel Works, where there are 7,000 hands, there were about 100 technically trained men, seven of the 23 leading officers being college graduates. Of 118 engineers on the staff of the Rapid Transit Railroad Commissioners of New York City, who are constructing a city underground railway, 84 per cent. had been college students; of 75 petty officers, 58 per cent. were college trained. In the Baldwin Locomotive Works, 43; on the Pennsylvania railway lines west of Pittsburg, 52, "nearly all being graduates"; at the Schenectady works of the General Electric Co., 264; the Illinois Central Railroad Co. employ 200 men who are "either graduates of a technical institution or have had some training in that line"; the Baltimore and Ohio Railway have employed in their maintenance of way department *since January, 1901*, 59 graduates of technical schools and universities, of whom 49 remain; the same company have this year begun to employ technical graduates in the yards and offices of the transportation department—17 have been thus engaged, 8 remain; in the mechanical and electrical departments the same company have 24 graduates among their 559 apprentices. These figures represent the specific statements made in some of the interviews and replies; the other statements were more general, the preponderance of opinion being in favour of technical graduates as industrial cadets.

My written inquiries were sometimes differently worded, but they were to this effect in all cases.

Do you "employ technically-trained men (*i.e.*, men trained in a school of commerce, in a manual training high school, or in a college like Cornell, or in an institute like the Boston Institute of Technology?

"(a.) On the industrial or productive side;

"(b.) On the commercial, or business, or selling side, of your firm; and, if so, what proportion do these bear to the whole number?

"(c.) Would you be good enough to give your opinions as to the best form of preparation for the industrial and for the business side of your work?

"(d.) Are college men preferable to boys who had only a high school education?

"It would appear to me that as the college bred men must be twenty-two years of age before they are ready to enter the 'works' or the office, they must be considerably handicapped in comparison with the boy who left school and entered the firm at sixteen or seventeen.

"If you have a type-written or printed statement of the conditions under which technically-trained men are admitted to your firm, I should be glad to have a copy.

"Perhaps you may also find it convenient to say whether there is still considerable room for the boy of ability and character who has not attended a technical institute or college, to rise from the ranks to the top of the firm."

To (a) and (b) the answer was generally "Yes."

The replies did not all say "Yes" with conviction, which is simply evidence that the sentiment in favour of college-bred men is common but not universal; that in fact we are not face to face with a resultant system, but with the incomplete operations of a formative process.

(c.) This question was too difficult but a college education is favoured.

(d.) The answer was "Yes," if the object in view was the preparation of the highest officers. The general opinion was that there is still room for the boy of marked ability to "come through," but that his difficulties are greatly increasing, and that useful as he is, his usefulness would have been greatly enhanced had he had the benefit of a college training. Agreement was common that the college graduate will go farther than the school boy, and rise more rapidly, because he has more behind him—a longer training and a "safety and security of knowledge." His progress will be more rapid, "notwithstanding," says Mr. Atterbury, General Manager of the Pennsylvania Railroad Co., "the fact that he may be handicapped by reason of his years."

"When," says Mr. Loree, President of the Baltimore and Ohio Railroad Co., "a college man has mastered the ordinary business practice, his superior intellectual training will soon tell in a readier grasp, broader view, and greater general capacity, and he will rapidly out-strip the other, who started earlier but with a limited mental equipment."

The whole of the written replies are given in an appendix (see p. 141) to this report. Their length and character form in themselves abundant testimony to the interest taken in educational questions by industrial leaders in the United States, and to the capacity of these leaders for mental detachment in adopting such a sympathetic attitude towards a stranger bringing *his* problems and inviting *their* help in solving them. They form also a remarkable body of evidence of the attitude of those hold-

ing the highest posts towards the hopes and prospects of those entering upon an industrial career; and in substance they so strongly support the view, as to formulate a demand, that those who hope to make the industry and commerce of the future must prolong their day school and college (technical) education until they are twenty-three, twenty-four, or twenty-five years of age. This is a lesson which we have, on the whole, yet to learn.

It is advisable to point out that apprenticeship is as loose a term in America as with us; that its use to cover "learners" of all kinds is, however, general because no better term exists. As a rule there are three kinds of apprenticeship:—

- I. The three or four years' apprenticeship system—somewhat analogous to our own, and occasionally provided to offer opportunities to sons of foremen, superintendents of shops, &c.
- II. The two years' course for college-bred men. These men are put through the shops in a short time. To apprentices of this class, I would propose to give the name "industrial cadets."
- III. A scheme of employment for sons of friends, relatives, &c., of heads of firms and of important customers.

I fear that in the United Kingdom III. is often confounded with II., to the disadvantage of the class who are provided for under system II. Apprentices under II. are paid 30s. per week during the period of probation, but, to the capable, advancement is rapid thereafter.

The demand for college men being great, managers are beginning to visit the technical schools and colleges before graduation, and to "size up" the outgoing students. One gentleman, who has this duty, informed me that he did not look for the first in studies, nor

**Qualities
sought for in
Industrial Cadets.**

the first at sports, nor indeed for those who exhibit pre-eminence in any one direction; but that he made his selection from the next in order, the men of good all-round ability, and of physique. Absence of certain social qualities would be a bar—not on grounds of class distinction, but of unfitness to be persuasive and tenacious amid opposition. The men must not be "too big for their boots," nor afraid of the grease and dirt of a factory, nor disposed to complain that their work and pay at initiation are beneath the dignity of a college man with such a high degree. They must not, as in cases I have known of on this side, interview the manager with a pipe in their teeth; nor adopt an attitude of patronage to the "works." Some of them do, of course, find the grease and dirt too disagreeable, and go; others—the men of grit—submit, and succeed. The early stages of an industrial cadet's work are undoubtedly none too pleasant, considering the men and their previous experience, and the pay is small, but the prospects are great for those who persist. It

will be seen that the need of the mechanical expertness of the factory or shop is not a factor in the selection of a cadet, the reason being that it is not material for skilled workmen or foremen which is being selected, but an executive officer, who must know how things are made and how they work; but who does not necessarily require to be a specially skilled operative.

Some firms offer special advantages to their young men. Believing in college education as they do, they permit young men to leave their works to attend a college, offer them employment during the summer vacation, and re-employ them when the college course is over.

It should not be assumed that the facts I have reported are confined to the few institutions and the few industrial undertakings which time permitted me to inquire into. I believe that the facts are common to all industrial concerns and educational institutions in the States, and that the operating causes are universal.

**Facts and Causes
Common.**

The cadets supplied are in great demand at present, because things industrial are booming; but it is believed that the demand under normal conditions will be sufficient to take care of the supply. American firms are too shrewd to demand what is not necessary or not useful; and the colleges provide what is necessary and useful, because they have realised that they are professional schools, and must turn out industrial cadets as capable of entering into practice as are graduates of medicine and law.

The "Schools of commerce" (of colleges and universities) are following in the footsteps of the institute of technology, and with the precedent in technology to point to, will before very long attain equal results.

In chapter IV. an endeavour has been made to set out a few of the features of technical education in America, dealing chiefly, and perhaps at too great length, with the methods of preparing the "captains of industry." In the present chapter an attempt has been made to show how this method of preparation is appreciated, and to indicate that the relationship between the schools and the industries has become one of supply and demand. It has also been explained that the quality of the supply is good, because the schools understand that they are professional schools, and that their graduates must be as capable of entering into practice as are graduates of medical colleges. A word in recapitulation may not be out of place.

Summary.

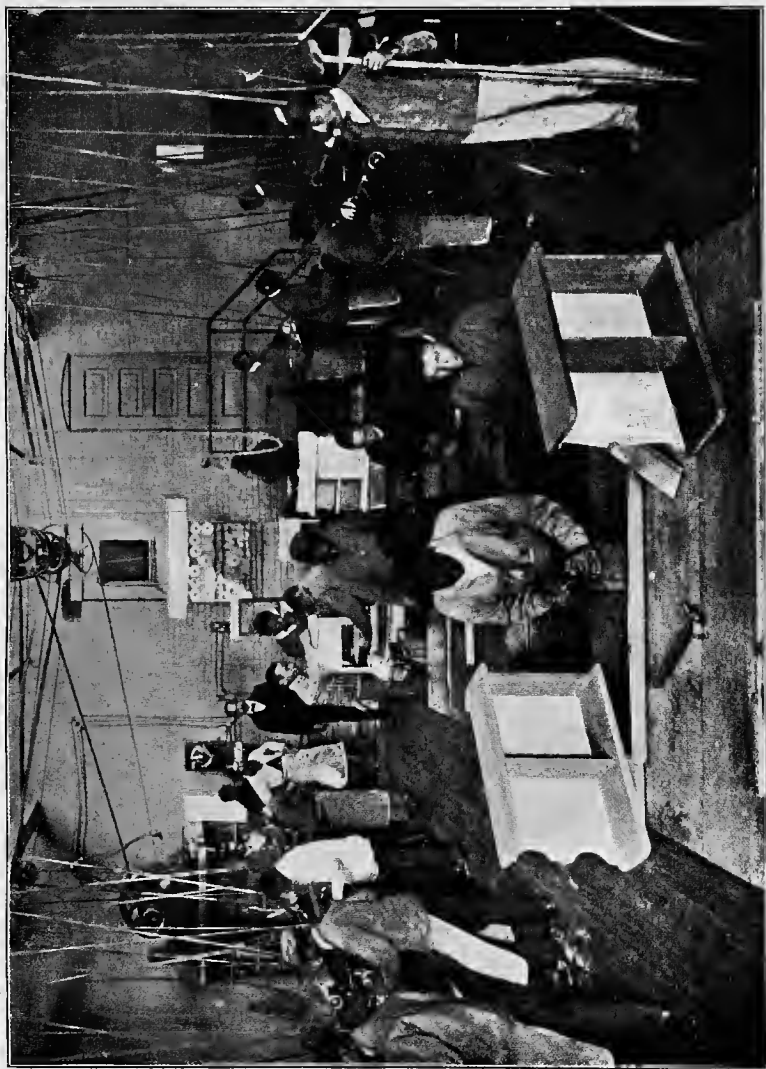
The American plan involves an elementary school course until fourteen years of age; four years at a high school; four years at a college or institute of technology, where instruction is industrial, and not academic, in character; and two years as an industrial cadet. In the schools there is no system of prize giving or ranking to misdirect the mind of the youth from the real objective of his preparation. No premium is required of

this youth on entering a "works." On the contrary, he is eagerly sought after, the managers believing that the future of their "works" depends on their ability to secure him. The pay is small; barely sufficient to live on. A young man will be twenty-five before he obtains a responsible post and be in a position to earn a fair living. After that, however, promotion is rapid, and prospects are great for the able and ambitious. The best ability in the States is to be found not in the professions and in politics, as with us, but in industries and commerce; partly the cause and partly the consequence of present conditions.

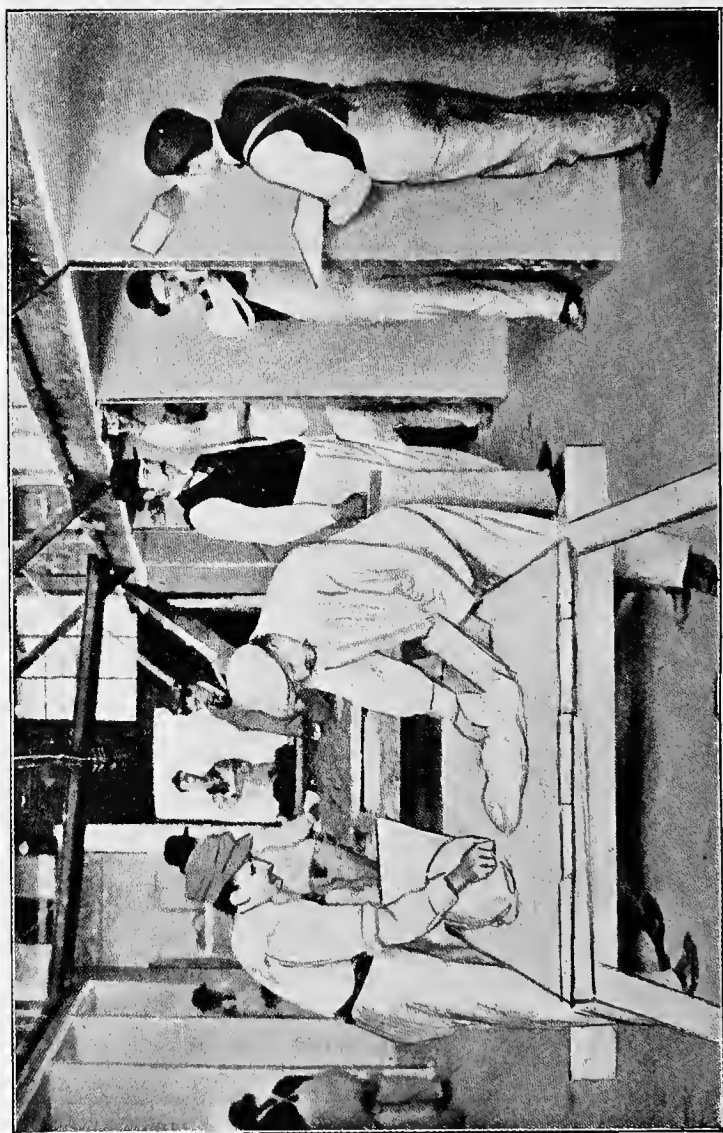
Compare this with the British plan. The number of students in British day technical colleges is insignificant when compared with the American figures. Further, British day technical courses are of three years' duration only, and, as a rule, are not based on a good general education of a secondary standard. The schools are not as professional in character as they might be, and the youth, when he has received his diploma, is somewhat diffident as to his capacity to tackle industrial problems. Further, he has great difficulty in securing a trial in a good firm, our industrial leaders having little or no faith in this kind of man. These features, the kind of product, and the want of faith, react against each other—in other words, there is no supply and demand. The usual means of entrance of prospective leaders into British works is the payment of a premium; and the premium boy usually goes into works at sixteen or so instead of going to college. This boy spends five years going round the workshops and the drawing office; he is not taught principles; that instruction has to be obtained at the evening technical school, or, in some rare cases, by a full three years' course at a technical school subsequent to his pupilage in the works. The premium is in most cases a perquisite of the high officer to whom the pupil is attached.

There is also the case of the regular apprentice who pays no premium. This boy if very able, very ambitious, and very strong physically, may succeed in reaching a post of responsibility; his aid is the evening technical school. In some rare cases he is successful in securing the assistance of a Whitworth Exhibition, and that brings instruction of a college standard.

Are we not asking too much of our youth? Let us take the case of a premium boy who leaves school at the age of sixteen or seventeen, and has become a pupil in some engineering firm. He is out of bed soon after 5 a.m.: into the works at 6: he leaves the works at 5.30 p.m.; he is at the technical school or studying at home on five nights per week from 7 to 9.30 or 10; and he is back to bed again at 10 or 10.30. On Saturday afternoon, the strain being over, he falls asleep in his boots. This hard work lasts from the end of September to the middle of May: and the 6—5.30 lasts all the year round. Are we not putting an unnecessarily severe strain on our very best material? In these days of international and industrial rivalry, can we afford to allow the "lad o'pairs" to sacrifice so much



Pattern Shop.—Armstrong Manual Training High School, Washington.



Plastering Department.—New York Trade School.

to the process of "coming through"? He will succeed in spite of obstacles, but he ought to reach the top with strength and faculties unimpaired—stronger, not weaker, from the ordeal.

The British plan of training leaders is distinctly inferior to the American; indeed we are not making the most of one of our most valuable national assets—the character and ability of our youth; and one of the most serious obstacles is the method of paying high officers. If we handicap our youth and do not make the best use of our national energy, then our industries will not compete on equal terms with those of America; for in natural resources, other than men, America has more valuable assets than we.

This report has already reached too great a length, and it is impossible now to deal with technical schools other than those already referred to, and with the possible applications to our own system of some of the features of American education.

It will be sufficient to add that the general effect of my inquiry has been to confirm views previously
Conclusions. held :—

(1.) That the problem of technical education is not a side issue, but an integral part of the problem of education in general.

(2.) That the solution of the problem of technical education, as of that of education in general, will be partial and incomplete unless the problem is attacked from the psychological as well as from the industrial and commercial point of view.

(3.) That the establishment of a close connection between institutions for technical education on the one hand, and industrial and commercial organisations on the other, is an essential factor in a successful solution of the problem of technical education, as of that of industrial and commercial progress.

APPENDICES.

**TECHNOLOGICAL INSTITUTIONS AND
COLLEGES.**

TECHNOLOGICAL INSTITUTIONS AND COLLEGES.

PRATT INSTITUTE, BROOKLYN, NEW YORK.

DEPARTMENTS :

HIGH SCHOOL, . . .	LUTHER GULICK, <i>Director</i> .
FINE ARTS, . . .	WALTER S. PERRY, <i>Director</i> .
DOMESTIC ART, . . .	HARRIET S. SACKETT, <i>Director</i> .
DOMESTIC SCIENCE, . . .	EDITH GREER, <i>Director</i> .
SCIENCE AND TECHNOLOGY, . . .	ARTHUR L. WILLISTON, <i>Director</i> .
KINDERGARTEN, . . .	ALICE E. FITTS, <i>Director</i> .
LIBRARY, . . .	MARY W. PLUMMER, <i>Director</i> .

DEPARTMENT OF SCIENCE AND TECHNOLOGY.

INSTRUCTORS AND ASSISTANTS.

Applied Mechanics, Mechanical Drawing, and Mechanical Laboratory, ...	6
Chemistry, ...	4
Physics, ...	4
Mathematics, ...	2
Applied Electricity and Electrical Laboratory, ...	3
Shop-work—Moulding, Forging, Carpentry, Machine-work, Manual Training, Plumbing, Fresco Painting, and House and Sign Painting, ...	11
Total, ...	30

CALENDAR—1902—1903.

DAY CLASSES.—September 22, 1902—June 18, 1903.

EVENING CLASSES.—September 29, 1902—March 27, 1903.

ENTRANCE EXAMINATIONS.—June and September, 1902.

DEPARTMENT OF SCIENCE AND TECHNOLOGY.

Requirements for Admission.—Applicants for admission to the courses in Steam and Machine Design and Applied Electricity should be at least seventeen years of age.

They must pass a *thorough* examination in Arithmetic showing that they clearly understand its principles and have facility in the numerical solution of problems. The examination will cover all branches, including percentage, interest, proportion, powers and roots, mensuration, and the metric system. Some knowledge of elementary Algebra, while not absolutely required, will be found very helpful.

They must also pass an examination in English Grammar and Composition which is intended to test the candidate's

ability to express himself in clear and correct English and to apply the principles of Grammar to the interpretation of obscure or involved passages.

Graduates in the regular course of approved high schools will be admitted without examination, but credentials less than the equivalent of this cannot be accepted.

Certificates.—The certificate of the Institute is granted to those students who satisfactorily complete either of the regular day courses.

Expenses.—The Institute is provided with an endowment which enables it to make the merely nominal charge for tuition of \$15·00 per term—three terms per year—and at the same time have the best talent and facilities for teaching, and the most complete equipment to supplement the instruction. No other fee is charged for registration or for material used by the student in the shops and laboratories.

Good room and board may be obtained in the vicinity of the Institute for \$5·00 to \$6·00 a week. Books, instruments and laboratory breakage cost \$15·00 to \$20·00 per year.

No scholarships are offered by the Institute, but its object is to aid those who are willing to aid themselves. While tuition fees are required, there is an endeavour to make possible, by some means consistent with self-helpfulness, the admission of every worthy applicant.

STEAM AND MACHINE DESIGN.

TWO YEAR DAY COURSE.

The object of this course is to give as thorough a Mechanical training as is possible in two years, and it is intended especially to prepare young men for the building of Steam Engines, Machine Tools, and similar kinds of Manufacturing, or for Power Plant work. It fits its graduates for positions as engineers' assistants, inspectors, draughtsmen, designers of machinery or superintendents of its construction or operation. The training given is of so practical a nature that they are sure to find it of immediate value and it is sufficiently thorough to enable them to rise to positions of responsibility.

COURSE OF STUDY.

The figure after each study represents the number of periods a week.

FALL TERM.		WINTER TERM.		SPRING TERM.	
Mathematics	5	Mathematics	5	Mathematics	5
(Algebra)		(Plane Geometry)		(Plane Trigonometry)	
Physics	5	Physics	5	Physics	5
(Mechanics)		(Heat and Light)		(Electricity)	
Physical Laboratory	6	Physical Laboratory	6	Physical Laboratory	6
Mechanical Drawing	8	Mechanical Drawing	8	Mechanical Drawing	8
(Projections)		(Shop Drawing)		(Engine Details)	
Machine Sketching	1	Machine Sketching	1	Machine Sketching	1
Shopwork	10	Shopwork	10	Shopwork	10
(Carpentry and Pattern-making)		(Pattern-making and Foundry)		(Forging)	

SECOND YEAR.

FALL TERM.		WINTER TERM.		SPRING TERM.	
Mathematics	5	Mathematics	5	Mathematics	5
(Advanced Algebra)		(Solid Geometry)		(Analytical Geometry)	
Mechanism and		Strength of Materials		Steam Engine and	
Mechanics	5	and Steam	5	Transmission of	
Machine Design	10	Machine Design	10	Power	5
Strength of Materials				Machine Design	10
Laboratory	8	Steam Laboratory	8	Steam Laboratory	8
Shopwork	10	Shopwork	10	Shopwork	10
(Machine Work)		(Machine Construc'n)		(Tool-making)	

APPLIED ELECTRICITY.

TWO YEAR DAY COURSE.

This course is intended for those who wish to enter Electrical Industries. It gives as complete a practical and theoretical training as is possible in two years and fits young men for positions in the building, installation, testing and operation of electrical machinery.

The constantly increasing number of applications of electricity in the arts is opening up new opportunities each year for employment and advancement to young men who are specially trained to grasp and understand the problems involved; and it is the aim of this course to furnish such special and practical training. With experience its graduates are able to fill such positions as operators, superintendents, and managers of electric lighting, railway, and power plants; constructors and designers in some of the various lines of applied electricity; or commercial and executive positions connected with the business management of such industries.

COURSE OF STUDY.

The figure after each study represents the number of periods a week.

FALL TERM.		FIRST YEAR.		SPRING TERM.	
Mathematics	5	Mathematics	5	Mathematics	5
(Algebra)		(Plane Geometry)		(Plane Trigonometry)	
Physics	5	Physics	5	Physics	5
(Mechanics)		(Heat and Light)		(Electricity)	
Physical Laboratory	6	Physical Laboratory	6	Physical Laboratory	6
Chemistry	2	Chemistry (Metals)	2	Chemistry	2
(Non-metals)		Chemical Laboratory	5	(Qualitative Analysis)	
Chemical Laboratory	5	Mechanical Drawing	6	Chemical Laboratory	5
Mechanical Drawing	6	(Shop Drawing)		Mechanical Drawing	6
(Projections)		Shopwork	6	(Engine Details)	
Shopwork	6	(Pattern-making and		Shopwork	6
(Carpentry and Pat-		Foundry)		(Forging)	
tern-making)					

SECOND YEAR.

FALL TERM.		WINTER TERM.		SPRING TERM.	
Mathematics	5	Mathematics	5	Mathematics	5
(Advanced Algebra)		(Solid Geometry)		(Analytical Geometry)	
Mechanism and Str.		Steam and the Steam-		Steam-engines and	
of Materials	3	engine	3	Steam-boilers	3
Applied Electricity	4	Applied Electricity	4	Applied Electricity	4
(Generation)		(Transmission)		(Motors & Lighting)	
Applied Electricity	8	Applied Electricity	8	Applied Electricity	8
(Laboratory)		(Laboratory)		(Laboratory)	
Mechanical Drawing	8	Mechanical Drawing	8	Mechanical Drawing	8
(Dynamo Details)		(Wiring Plans)		(Power Plants)	
Shopwork	6	Shopwork	6	Shopwork	6
(Vice-work)		(Machine-work)		(Dynamo Construct'n)	

METHODS OF INSTRUCTION AND EQUIPMENT.

Physics.—The Department of Physics occupies a large lecture room, two laboratories and a weighing room on the third floor of the Science and Technology Building, besides two other laboratories, a lecture-room, stock-room, small shop, and a special photometer-room equipped with a Reichsanstalt precision photometer, on the connecting floor of the Electrical Building.

Chemistry.—This department occupies the fourth floor of the Science and Technology Building, with a lecture-room, two large laboratories, for general chemistry and qualitative analysis, accommodating 25 and 20 students at a time, another laboratory for quantitative work, a balance-room, equipped with eleven chemical balances, an assay room, and a private laboratory and office. The instruction in the first year of the Course in Applied Electricity covers, by lectures, recitation, and laboratory practice, general chemistry in the first two terms, and in the third term, qualitative analysis.

Shop-work.—The Carpenter and Pattern Shop is equipped with thirty benches and twenty-five 14-inch pattern-makers' lathes, each furnished with the necessary tools; besides two circular saws, a band-saw, scroll-saw, two planers, a mortising machine, and a trimmer.

The Foundry is provided with a cupola of one ton melting capacity, for iron; two brass furnaces; a core oven; twenty-four moulders' benches with a full assortment of moulders' tools; and a considerable open space for floor moulding, with a travelling crane for handling large moulds.

The Forge Shop contains twenty-five forges, each with its anvil and hand tools, vice-benches, a drilling machine and a foot-power hammer. The air blast is furnished by fans driven by a separate motor.

The Machine Shop is equipped with forty-four machine tools of various types, including eighteen engine-lathes from 13 to 28 inch swing, two planers, two shapers, a universal milling machine, three upright drills, two punch presses, and a variety of grinding machines. There are also thirty-five vice benches fully equipped and a tool-room in which is kept a large assortment of special tools, drills, reamers, milling cutters, counter-bores, taps, dies, arbors, and special tools which are used by the students throughout the work.

Each of the students, or a number of them jointly, before the end of the course, constructs one or more completed machines, such as an independent chuck, a punch-press, a twist-drill grinder, a shaper, a dynamo, an engine-lathe, or a milling machine. They make the patterns which they use to make their own castings in the Foundry, and in the Machine Shop they not only get the experience of building and assembling the complete machines, but also of making the milling cutters, taps, counter-bores, and the other special tools necessary for its construction. Thus they learn every step in the process of manufacture by doing the work themselves.

Steam Engine.—The Steam Laboratory is equipped with plain slide-valve, automatic cut-off, and Corliss engines, as well as with a gas engine, simple and compound steam pumps, air-pumps, condensers, &c., so that there is abundant opportunity for gaining experience in the handling of such machinery.

The students obtain much practice in valve setting, and make numerous tests on the various engines and pumps in the Laboratory, condensing and non-condensing, and under various conditions of working, in order that they may determine the best and most economical conditions. They also conduct complete boiler tests and receive practical instruction and experience in the firing of boilers.

Mechanics and Strength of Materials.—The Strength of Materials Laboratory is equipped with a 100,000 pound tension and compression machine, a smaller machine with a capacity of 35,000 pounds, two beam machines, a torsion machine, and a number of machines for smaller work, so that the students have opportunity for individual experimentation on large specimens, and have time to study the materials under test until they thoroughly understand their behaviour.

Mechanical Laboratory.—The laboratories have recently been much enlarged and occupy the greater part of two entire floors in the Electrical Building. Besides the practice in valve setting, engine and boiler testing and in strength of materials already described, experiments are conducted on a variety of smaller steam apparatus such as injectors, calorimeters, separators, flow of steam, indicator testing, &c.; on power measurement and transmission, the efficiency of belt drives, &c., and in hydraulics.

Applied Electricity.—Practice is given in the use of measuring instruments—Wheatstone bridge, voltmeter, ammeter, wattmeter, Kelvin balance, and dynamometer in a specially constructed testing laboratory furnished with isolated masonry piers. And in the Electrical Laboratory, which is equipped with a model plant, including Corliss and automatic engines, various types of dynamos, switchboards, transformers, motors, and lighting apparatus, opportunity is afforded for experimental study and for varied and continuous practice in the operation of electrical machinery. Considerable practice is also had in wiring for switchboards and electric lighting, in armature winding, and in the construction and repair of electrical machinery.

EVENING TECHNICAL COURSES.

The following evening courses are provided for those whose regular occupation prevents them from attending a day course. The aim is, so far as the time allows, to furnish a thorough and practical training in the various branches which will be of immediate value to the student, by increasing his technical information, and enabling him to advance to positions of greater responsibility in his special line. By attendance, in successive years, upon several of these courses a fairly complete Mechanical or Electrical Course may be obtained.

The theoretical instruction in every case is supplemented in each session by individual practice in the laboratories or drawing-rooms, and all of the apparatus and laboratories of this Department are available for these classes.

The outfit lent each student includes everything needed for the most thorough individual work, and the size of all the classes is limited, so that each student may have abundant room to carry on his work under the personal oversight of the instructor.

Examinations.—Entrance examinations in Arithmetic and Algebra through Simple Equations are required for the course in Applied Electricity, and one in Arithmetic for the courses in Steam and the Steam-engine, and Strength of Materials.

Applicants who have taken the Course in Physics will be given preference in admission to all the other courses.

All classes meet on Monday, Wednesday, and Friday evenings from 7.30 to 9.30 between September 29 and March 27.

Tuition Fees.—Tuition is \$15.00 per year for all courses, or \$8.00 per term for Steam and the Steam-engine or Strength of Materials.

COURSES OF STUDY.

ELEMENTARY
ELECTRICITY AND
PHYSICS,

One Year.

Principles of mechanics; equilibrium of forces, pressure of gases, laws of motion, work, energy, and friction; heat and ventilation. Magnetism, static and current electricity, and electrical measurements. Two lectures and four hours of laboratory work each week.

CHEMISTRY,

Three Years.

First year: Principles of general chemistry and of chemical combinations, properties of the non-metallic and metallic elements and their compounds. Second year: Qualitative analysis; the separation and determination of the various metals and acids in solution and in solids. Third year: Quantitative analysis by weight and by volume, elements of assaying. Lectures and laboratory work, throughout the three years. An Evening Certificate is granted upon successful completion of this course.

APPLIED
ELECTRICITY,

One Year.

Lectures and laboratory practice in operation of dynamos and motors; principles of electricity and magnetism and their application to power plant and electric lighting work.

MECHANICAL DRAWING, Two Years.	{ First year: Use of instruments; principles of working-drawings; development and intersection of surfaces; projection and shop drawing, etc. Second year: Advanced shop drawing; machine design.
MECHANISM, One Year.	{ Lectures and drawing. Mechanical movements carefully analysed and worked out on the drawing-board. Problems on cams, gear-teeth, different forms of link-work, etc. The course in Mechanical Drawing or an equivalent is required for admission.
STEAM AND THE STEAM ENGINE, First Term Only.	{ Lectures dealing with the laws of heat, combustion of fuel, and steam generation; properties of steam; condensing and non-condensing engines; value of single, compound, and triple expansion. Laboratory practice in setting slide-valves, taking indicator cards, and calculating horse-power and other data, and making tests of engine efficiency.
STRENGTH OF MATERIALS, Second Term Only.	{ The instruction deals with the stresses and strains in floors, beams, and girders; columns; shafting; boilers and riveted joints, etc.; and the behaviour of the materials of construction under strain. Individual experiments and tests on large specimens form an important feature of the work. This course follows Steam and the Steam-engine and is of great value to the practical engineer and mechanic as well as to the architect and builder.

EVENING TRADE CLASSES.

The following evening trade classes are provided for those whose regular occupation would prevent them from attending a day class. They furnish a thorough and practical training in the various trades, which will be of immediate value to each one attending by giving him greater skill, accuracy, and a knowledge of the technical points of his trade; familiarising him with the best modern methods; thus preparing him for advancement and increasing his earning power.

Each one of the shops is provided with all the machines, tools, or special apparatus for the particular trade which can promote the objects and increase the value of the instruction.

Applicants for these evening trade classes must be between sixteen and twenty-five years of age, and applications should be made before the term opens.

All classes meet on Monday, Wednesday, and Friday evenings, from 7.30 to 9.30, from September 29 to March 27.

CLASSES.

CARPENTRY, Two Years.	{ A practical trade course in carpentry and joinery; practical examples of house-framing, doors, sashes, etc., and all the essential points of the trade. Also an advanced course, taking up work in roof-framing, stair-building, or in pattern-making, as the applicant may elect.
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MACHINE-WORK, . Two Years.	{ One term of bench-work and one term of practice on the engine-lathe, planer, shaper, and milling-machine. This is followed by actual machine construction and high-grade machine work, including tool-making, with considerable practice on the milling-machine and grinding-machine. Experienced machinists will find this work of great value. An Evening Certificate is granted upon successful completion of this course.
PLUMBING, . Two Years.	{ The Journeymen Plumbers' Association of Brooklyn co-operates in the direction of this class. The manual work includes practice in soldering and wiping the various types of joints; making bends and traps; and all other forms of practical plumbing. The lectures deal with the proper arrangements of drain, soil, and waste pipes; trapping; ventilation; supply pipes; boilers; tanks; fixtures, etc. An Evening Certificate is granted upon successful completion of this course.
SIGN PAINTING, . Two Years.	{ Practice in spacing and plain lettering; ornamental lettering in gold and colours on wood, glass, metal. Composition of signs; scroll-work; wagon painting; striping; pictorial work.
FRESCO PAINTING, . Two Years.	{ Preparing walls and ceilings in calcimine; lining; stencil-work; flat and shaded ornament; and flower painting. Study of design and advanced ornamental decoration on wall and ceiling.

Tuition fees—\$15.00 per year for each course.

ENROLMENT.

The enrolment of the Department of Science and Technology for the year 1902-3 was as follows :—

DAY COURSES.

First-year Applied Electricity, ...	63
First-year Steam and Machine Design, ...	63
Second-year Applied Electricity, ...	42
Second-year Steam and Machine Design, ...	42
Special Mechanical students, ...	12
Total enrolment in Day Courses, ...	222

EVENING TECHNICAL COURSES.

* Applied Electricity, ...	36
Physics, ...	30
Chemistry, first year, ...	30
Chemistry, second year, ...	19
Chemistry, third year, ...	16
Mechanical Drawing, ...	62
Machine Design, second year, ...	33
Mechanism, third year, ...	11
Steam and the Steam Engine (fall term only)	31
Strength of Materials (winter term only), ...	24

Total enrolment of Evening Technical Courses, ... 293

EVENING TRADE CLASSES.

Carpentry, ...	31
Machine Work, ...	66
Plumbing, ...	64
Sign Painting and Fresco Painting, ...	45
Total enrolled in Evening Trade Classes, ...	206
Total receiving instruction in Department of Science and Technology, ...	721
Students from other departments receiving instruction in the Department of Science and Technology, ...	263
Grand total, ...	984

The following table gives the number of students enrolled in the day and evening courses for the past six years; and so far as additional facilities for the accommodation of larger classes have been provided, it shows the increased demand for the industrial education represented in the courses of instruction.

—	1897-98.	1898-99.	1899-00.	1900-01.	1901-02.	1902-03.
Day Courses, ...	69	78	96	136	191	222
Evening Technical Courses, ...	174	171	199	213	251	293
Evening Trade Classes, ...	89	111	135	150	169	206
Totals, ...	332	360	430	499	611	721

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, BOSTON.

Session : Sept. 30, 1903—June 7, 1904.

GENERAL INFORMATION.

Historical Sketch.—The foundation of the Massachusetts Institute of Technology was laid in a "Memorial" prepared in 1859 by Professor William Barton Rogers, and presented, by a Committee, to the Legislature of 1860. In this Memorial "reference is made to the expected early establishment of a comprehensive Polytechnic College, furnishing a complete system of industrial education supplementary to the general training of other institutions, and fitted to equip its students with every scientific and technical principle applicable to the industrial pursuits of the age."

On May 28, 1860, a sub-committee, consisting of Professor Rogers and Messrs. E. B. Bigelow and J. M. Beebe, was appointed to "mature a plan for a polytechnic institution." To this sub-committee Messrs. M. D. Ross and C. H. Dalton were subsequently added, and for it Professor Rogers, during the summer of 1860, prepared an elaborate report entitled, "OBJECTS AND PLAN OF AN INSTITUTE OF TECHNOLOGY."

A preliminary session of the School of Industrial Science was opened, fifteen students attending, on Feb. 20, 1865. The regular courses of instruction began Oct. 2, 1865.

Charter and Government.—On April 10, 1861, a legislative Act was passed to incorporate the Massachusetts Institute of Technology, and to grant aid to said Institute and to the Boston Society of Natural History. William B. Rogers, together with twenty other members, was named in the Act. They, with their associates and successors, were made a body corporate under the above title, "for the purpose of instituting and maintaining a society of arts, a museum of arts, and a school of industrial science, and aiding generally by suitable means the advancement, development, and practical application of science in connection with arts, agriculture, manufactures, and commerce."

A square of State land on Back Bay, in Boston, was set apart as an open space, and the corporation was allowed upon certain conditions to erect buildings covering not more than one-third part of the westerly two-thirds of this square.

The corporation was authorized to hold property to an amount not exceeding two hundred thousand dollars.

May 30, 1865, an additional Act authorized holding property yielding an annual income of thirty thousand dollars.

Feb. 29, 1888, an additional Act raised the limit to property yielding an income of one hundred thousand dollars.

April 27, 1863, an additional Act allotted to the Institute one-third of the interest received by the State from the United States Land Grant, to support colleges of agriculture and the mechanic arts, under the condition that instruction in military tactics should be provided, and that the Governor, the Chief Justice of the Supreme Court, and the Secretary of the State Board of Education should be each a member *ex-officio* of the Government of the Institute.

The control of the Institute was exercised by a body called the Government, elected from among its members. The form of the Government at first constituted proved inconvenient: a change was made in the mode of selection of the governing body, and the present Government of the Institute derives its powers from a charter of March 20, 1869.

The School of Industrial Science has become the prominent feature of the Institute; and, indeed, nearly all persons know this, and this alone, as the Institute. It is devoted to investigation and the teaching of science as applied to the various engineering professions; namely, civil, mechanical, mining, electrical, chemical, and sanitary engineering, and naval architecture, as well as to architecture, chemistry, metallurgy, biology, physics, and geology. A course of a less technical nature, designed as a preparation for business callings, is also provided.

A subsidiary school, known as the MASSACHUSETTS SCHOOL OF DESIGN, is maintained by the Corporation of the Institute.

The Society of Arts aims to awaken and maintain an interest in the practical applications of the sciences, and to aid in their advancement. Meetings are held semi-monthly from October to May, at which reports of inventions, discoveries, and matters of scientific and technical interest are presented.

Buildings.—The buildings now occupied are the Rogers Building, on Boylston-street, devoted to instruction in mining engineering and metallurgy, mathematics, literature, history, and political science, and containing the administrative offices and the general library; the Walker Building, on Boylston and Clarendon Streets, devoted to the departments of chemistry and physics; the engineering buildings, on Trinity Place, devoted to the engineering laboratories, to instruction in applied mechanics and hydraulics, and to the departments of civil and mechanical engineering and naval architecture; the Henry L. Pierce Building, also on Trinity Place, occupied by the departments of architecture, biology, geology, and by the laboratories of industrial chemistry and textile colouring; the Lowell Building, on Clarendon Street, designed primarily to furnish laboratories for the department of electrical engineering, but occupied also by the department of modern languages; a series of mechanical laboratories on Garrison Street; and a gymnasium on Exter Street. Work is soon to be begun on the Walker Memorial Building, a gymnasium and student club-house, the fund for which has been contributed largely by past and present students, in memory of the late President Walker.

COURSES OF INSTRUCTION.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY provides instruction in the sciences and their applications to the arts. Its Courses embrace also such general studies as are essential for a liberal education.

The fundamental elements in the curriculum of the school are mathematics, chemistry, and physics. The general training acquired in these introductory studies prepares the student, on the one hand, for more advanced and specialized scientific work, and it constitutes, on the other hand, the foundation for the technical courses in engineering, chemistry, and architecture. Instruction in technical methods is subordinated to the acquisition of principles, and these principles are studied with the predominant purpose of exercising the powers and training the faculties.

The Institute offers thirteen distinct undergraduate Courses, each of four years' duration.

For the satisfactory completion of any one of these Courses the degree of Bachelor of Science is conferred. Of the thirteen Courses, eight give their students scientific and practical training for the various engineering professions; four others, namely, those in Chemistry, Physics, Biology, and Geology, embrace a larger proportion of pure science and afford preparation either for professional practice, for teaching, or for scientific investigation. While the Institute of Technology is primarily a school of applied science, there has been no time since its foundation when its degree could be attained without a considerable amount of literary, historical, and economic study. All regular students are accordingly required to pursue such studies through at least three years.

The growing appreciation of the value to technological students of a broader training than can be obtained from purely technical courses has led the Faculty to require of regular students, in addition to the general studies of the curriculum, a substantial amount of reading during the summer vacation.

Women may be admitted to any of the Courses of the school.

Choice of Courses.—At the end of the first half-year, which is the same for all Courses, the student selects, subject to the approval of the Faculty, the Course which he will thenceforth pursue, and his work becomes more specialized thereafter as it progresses.

Options.—Within most of the regular Courses the student is given, by means of options, a considerable latitude in the selection of the branch of his intended profession to which he shall specially devote his energies in the later years of his study. Thus in Civil Engineering he may elect sanitary and hydraulic engineering, geodesy, or an advanced course in railroad engineering and management; in Mechanical Engineering he may choose either marine engineering, locomotive construction, mill engineering, or heating and ventilation; and similarly for other Courses.

Graduate Courses of study may be pursued, either with or without reference to advanced degrees, by graduates of the Institute or by other persons of equivalent training.

Five-Year Courses.—Students purposing to take the degree of the Institute, but for sufficient reasons finding it advantageous to take at once fewer studies than are prescribed in the schedules for the regular four-year Courses, may arrange to distribute the entire work over five instead of four years.

SCHEDULES OF THE FIRST-YEAR COURSES.

FIRST TERM.

(Common to all Courses.)

Algebra.	Freehand Drawing.
Plane Trigonometry.	French. ¹
Inorganic Chemistry ; Chemical Laboratory.	Rhetoric and English Composition.
Mechanical Drawing.	Military Science.

SECOND TERM.

COURSES I., II., III., VI., VIII. (3),
X., XI., XII., XIII.

Analytic Geometry.
Inorganic Chemistry ; Qualitative Analysis ; Chemical Laboratory.
Descriptive Geometry.
Freehand Drawing.
French.¹
English.
United States History.
Military Science.

COURSE IV.

Materials of Architecture (Opt. 1, 2).
Shades and Shadows (Opt. 3).
Analytic Geometry.
Descriptive Geometry.
Modelling.
Freehand Drawing.
French.¹
English.
United States History.
Military Science.

COURSE V.

Inorganic Chemistry ; Qualitative Analysis ; Chemical Laboratory.
Elements of Plane Analytic Geometry.
Descriptive Geometry.
Freehand Drawing.
Wood and Metal Work.
French.¹
English.
United States History.
Military Science.

COURSE VII.

Inorganic Chemistry ; Qualitative Analysis ; Chemical Laboratory.
Industrial Microscopy.
Elements of Plane Analytic Geometry.
Mechanical Drawing.
Freehand Drawing.
French.¹
English.
United States History.
Military Science.

COURSE VIII. (1, 2).

Analytic Geometry.
Inorganic Chemistry ; Qualitative Analysis ; Chemical Laboratory.
Mechanical Drawing.
Freehand Drawing.
Wood and Metal Work.
French.¹
English.
United States History.
Military Science.

COURSE IX.

The schedule of this Course is in process of revision.

¹ Students who have passed French II. before entrance are advised to take German II. For more advanced elective courses in French and German, see the Subject Schedule of the Catalogue.

I.—CIVIL ENGINEERING.

Civil engineering is the broadest in scope of the engineering professions, being the parent stem from which have diverged all the other branches; but, even though these have become recognized as distinct professions, the field of civil engineering still remains so large that no one can become expert in its whole extent. It covers topographical engineering; the building of railroads, harbours, docks, and other works serving the purposes of commerce and transportation; municipal engineering, including the construction of sewers, water-works, roads, and streets; structural engineering, including the construction of bridges, buildings, walls, foundations, and all fixed structures; hydraulics, the development of water power and other branches.

SECOND YEAR.

FIRST TERM.

Surveying and Plotting.
 Elements of Astronomy.
 General Geology.
 Differential Calculus.
 Spherical Trigonometry.
 Physics: Mechanics, Wave-motion, Electricity (lectures).
 Descriptive Geometry.
 German (or French).
 English Literature.
 European History.

SECOND TERM.

Surveying and Plotting.
 Topographical Drawing.
 Principles of Mechanism.
 Structural Geology.
 Integral Calculus.
 Physics: Electricity, Optics (lectures).
 German (or French).
 English Literature and Composition.

THIRD YEAR.

FIRST TERM.

Railroad Engineering: Field-work and Drawing.
 Advanced Surveying.
 Stereotomy.
 Topographical and Field Geology.
 Physics: Heat.
 Physical Laboratory.
 Statics; Stresses in Frames; Kinematics and Dynamics.
 German (or French).
 Political Economy.

SECOND TERM.

Railroad and Highway Engineering; Field-work and Drawing.
 Advanced Surveying.
 Theory of Structures.
 Applied Geology; Building Stones.
 Physical Laboratory.
 Strength of Materials; Theory of Elasticity.
 German (or French).
 Political Economy and Industrial History.
 Business Law.

FOURTH YEAR.

FIRST TERM.

Theory of Structures: Bridges
and Similar Structures.
Bridge Design.
Foundations.
Theoretical Hydraulics.
Industrial Electricity.
Steam Engineering.
Metallurgy of Iron.

Options.

- 1 { Sanitary and Hydraulic Eng.
Hydraulic Measurements.
Practical Astronomy.
- 2 { Railroad Engineering.
Railroad and Highway Design.
Railroad Management.

SECOND TERM.

Theory of Structures: Bridges
and Similar Structures.
Advanced Structures.
Bridge Design.
Steam Engineering.
Engineering Laboratory.
Thesis.

Options.

- 1 { Hydraulic Engineering.
Elements of Geodesy.
Hydraulic and Sanitary Design.
Sanitary Science and Public
Health.
- 2 { Railroad Engineering.
Railroad and Highway Design.
Building Construction.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

II.—MECHANICAL ENGINEERING.

SECOND YEAR.

FIRST TERM.

Principles of Mechanism.
Mechanical Engineering Drawing.
Carpentry and Wood-turning.
Differential Calculus.
Physics: Mechanics, Wave-mo-
tion, Electricity (lectures).
Descriptive Geometry.
German (or French).
English Literature.
European History.

SECOND TERM.

Mechanism: Gear-teeth; Ma-
chine-tools; Cotton Machinery.
Valve-gears.
Mechanical Engineering Drawing.
Pattern Work.
Foundry (elective).
Integral Calculus.
Physics: Electricity, Optics (lec-
tures).
German (or French).
English Literature and Composi-
tion.

THIRD YEAR.

FIRST TERM.

Steam Engineering: Thermo-
dynamics.
Mechanical Engineering Drawing.
Dynamo-electric Machinery.
Forging.
Elements of Differential Equa-
tions.
Physics: Heat.
Physical Laboratory.
Statics; Kinematics and Dyna-
mics.
German (or French).
Political Economy.

SECOND TERM.

Steam Engineering: Boilers.
Drawing Design, and Boiler
Drawing.
Use of Surveying Instruments.
Engineering Laboratory.
Forging; Chipping and Filing.
Physical Laboratory.
Strength of Materials; Kinema-
tics and Dynamics; Graphical
Statics.
German (or French).
Political Economy and Industrial
History.
Business Law.

FOURTH YEAR.

FIRST TERM.

Steam Engineering.
Machine Design.
Theoretical Hydraulics.
Dynamics of Machines.
Engineering Laboratory.
Chipping and Filing; Machine-tool Work.
Strength of Materials; Friction.
Heating and Ventilation.¹
Metallurgy of Iron.

Options.

1. Marine Engineering.
2. Locomotive Construction.
3. Mill Engineering.
4. { Heating and Ventilation.
Dynamo-electric Machinery.
Hygiene of Ventilation and Heating.

SECOND TERM.

Hydraulic Motors.
Engineering Laboratory.
Machine-tool Work.
Strength and Stability of Structures; Theory of Elasticity.
Foundations.
Industrial Management.
Thesis.

Options.

1. Marine Engineering.
2. Locomotive Construction.
3. Mill Engineering.
4. Heating and Ventilation.

¹ Not taken by Option 4.

Students entering after 1902 take German II. in their second year, and have no further requirements in modern languages.

III.—MINING ENGINEERING AND METALLURGY.

SECOND YEAR.

FIRST TERM.

Mineralogy.
Differential Calculus.
Physics: Mechanics, Wave-motion, Electricity (lectures).
German (or French).
English Literature.
European History.

Options.

- 1 { Surveying and Plotting.
General Geology.
- 2 { Blowpipe Silver Assay.
Descriptive Geometry.
Principles of Mechanism.

SECOND TERM.

Integral Calculus.
Physics: Electricity, Optics (lectures).
German (or French).
English Literature and Composition.

Options.

- 1 { Surveying and Plotting.
Topographical Drawing.
Structural and Stratigraphical Geology.
Mineralogy.
Field Geology.
- 2 { Mechanism: Gear-teeth; Machine-tools.
Valve-gears.
Theoretical Chemistry.
Mechanical Engineering Drawing.

SUMMER COURSE IN PRACTICAL MINING OR METALLURGY (ELECTIVE).
FIELD-WORK IN MINERALOGY (ELECTIVE).

THIRD YEAR.

FIRST TERM.

Assaying.
Qualitative Analysis (lectures and laboratory).
Physics: Heat.
Physical Laboratory.
Statics; Stresses in Frames.
German (or French).
Political Economy.

Options.

- | | | |
|---|---|-------------------------------------|
| 1 | { | Mining Engineering. |
| | | Economic Geology. |
| | | Chemical Geology and Ore-deposits, |
| 2 | { | Dynamo-electric Machinery. |
| | | Steam Engineering: Thermo-dynamics. |
| | | Mechanical Engineering Drawing. |

SECOND TERM.

Quantitative Analysis (lectures and laboratory).
Physical Laboratory.
Strength of Materials; Kinematics and Dynamics.
German (or French).
Political Economy and Industrial History.
Business Law.

Options.

- | | | |
|---|---|-----------------------------|
| 1 | { | Mining Engineering. |
| | | Theoretical Chemistry. |
| | | Steam Engineering; Boilers. |
| 2 | { | Engineering Laboratory. |

SUMMER COURSE IN PRACTICAL MINING OR METALLURGY (ELECTIVE)

FOURTH YEAR.

FIRST TERM.

Mining Engineering: Ore-dressing.
Memoirs, Laboratory Reports.
Metallurgy (non-ferrous).
Metallurgy of Iron.
Metallurgical Laboratory.
Quantitative Analysis (lectures and laboratory).
Heat Measurements.
Theoretical Hydraulics.
Strength of Materials: Friction.

SECOND TERM.

Mining Engineering: Mining and Metallurgical Machinery.
Memoirs, Laboratory Reports.
Metallurgy (non-ferrous).
Metallurgical Laboratory.
Quantitative Analysis (lectures and laboratory).
Thesis.

Options.

1. Quantitative Analysis (additional).
2. Engineering Laboratory.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

IV.—ARCHITECTURE.

(General and Architectural Engineering.)

SECOND YEAR.

FIRST TERM.

Elementary Design.
Architectural History.
Theory of Architecture.
Shades and Shadows.
Freehand Drawing.
Differential Calculus.
Physics: Mechanics, Wave-motion, Electricity (lectures).
German (or French).
English Literature.
European History.

SECOND TERM.

Design.
Architectural History.
Theory of Architecture.
Stereotomy.
Freehand Drawing.
Integral Calculus.
Physics: Electricity, Optics (lectures).
German (or French).
English Literature and Composition.

THIRD YEAR.

FIRST TERM.

Design.
 Architectural History.
 Perspective.
 Specifications and Working Drawings.
 Freehand Drawing.
 Heating and Ventilation.
 Statics; Stresses in Frames.
 German (or French).
 Political Economy.

SECOND TERM.

Architectural History.
 Freehand Drawing.
 Pen-and-ink.
 Strength of Materials; Graphical Statics.
 German (or French).
 Political Economy and Industrial History.
 Business Law.

Options.

- | | | |
|---|---|--------------------------|
| 1 | { | Design. |
| | | Building Stones. |
| 2 | { | Theory of Structures. |
| | | Structural Design. |
| | | Heating and Ventilation. |

FOURTH YEAR.

FIRST TERM.

History of Construction.
 European Civilization and Art.
 Pen-and-ink.

Options.

- | | | |
|---|---|------------------------|
| 1 | { | Design. |
| | | Constructive Design. |
| | | History of Ornament. |
| | | Life Class. |
| | | Water-colour. |
| 2 | { | Strength of Materials. |
| | | Acoustics. |
| | | Theory of Structures. |
| | | Structural Design. |
| | | Strength of Materials. |

SECOND TERM.

Business Relations.
 European Civilization and Art.
 Sanitary Science and Public Health.
 Design; Thesis.

Options.

- | | | |
|---|---|---|
| 1 | { | History of Ornament. |
| | | Life Class. |
| | | Modelling. |
| | | Pen-and-ink. |
| | | Water-color. |
| 2 | { | Color. |
| | | Theory of Structures. |
| | | Building Stones. |
| | | Laboratory Tests of Building Materials. |
| | | |

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

IV.—ARCHITECTURE.

(Landscape).

SECOND YEAR.

FIRST TERM.

Elementary Design.
 Architectural History.
 Theory of Architecture.
 Horticulture.
 General Biology.
 Surveying.
 General Geology.
 Freehand Drawing.
 Physics: Mechanics, Wave-motion, Electricity (lectures).
 German (or French).
 English Literature.
 European History.

SECOND TERM.

Design.
 Architectural History.
 Theory of Architecture.
 Horticulture.
 Elements of Botany.
 Structural Geology.
 Surveying.
 Freehand Drawing.
 Physics: Electricity, Optics (lectures).
 German (or French).
 English Literature and Composition.

THIRD YEAR.

FIRST TERM.

Design.
 Architectural History.
 Perspective.
 Horticulture.
 Curves and Earthwork.
 Topographical and Field Geology; Elements of Natural Landscape.
 Freehand Drawing.
 German (or French).
 Political Economy.

SECOND TERM.

Landscape Design.
 Horticulture.
 Highway Engineering: Field-work and Drawing.
 Architectural History.
 Freehand Drawing.
 Pen-and-ink.
 Applied Geology; Building Stones.
 German or French.
 Political Economy and Industrial History.
 Business Law.

FOURTH YEAR.

FIRST TERM.

Landscape Architecture.
 Landscape Design.
 Horticulture.
 Specifications and Working Drawings; Landscape Gardening.
 Sanitary Engineering; Masonry.
 History of Ornament.
 Life Class.
 Pen-and-ink.
 Water-colour.
 European Civilization and Art.

SECOND TERM.

Landscape Architecture.
 Landscape Design: Thesis.
 Horticulture.
 History of Ornament.
 Business Relations.
 Life Class.
 Modelling.
 Pen-and-ink.
 Water-colour.
 Sanitary Science and Public Health.
 Photography.
 European Civilization and Art.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

V.—CHEMISTRY.

SECOND YEAR.

FIRST TERM.

Qualitative Analysis (lectures and laboratory).
 Mineralogy.
 Physics: Mechanics, Wave-motion, Electricity (lectures).
 German (or French).
 English Literature.
 European History.

Options.

1. Descriptive Geometry.
- 1, 5. Differential Calculus.
- 2, 3, 4. { Elements of Differential and Integral Calculus.

SECOND TERM.

Quantitative Analysis (lectures and laboratory).
 Physics: Electricity, Optics (lectures).
 Physical Laboratory.
 Physical Measurements (lectures).
 German (or French).
 English Literature and Composition.

Options.

- 1, 5. Integral Calculus.
- 2, 3, 4. { Mineralogy.
- { General Biology.
- { Industrial Microscopy.

THIRD YEAR.

FIRST TERM.

Quantitative Analysis (lectures and laboratory).
 Industrial Chemistry.
 Physics: Heat.
 Physical Laboratory.
 Industrial Electricity.
 German (or French).
 Political Economy.

SECOND TERM.

Quantitative Analysis (lectures and laboratory).
 Theoretical Chemistry.
 Organic Chemistry (brief course).
 Industrial Chemistry.
 Assaying.
 German (or French).
 Political Economy and Industrial History.
 Business Law.

THIRD YEAR—continued.

<i>Options.</i>		<i>Options.</i>	
1.	Mechanism and Drawing.	1, 2.	Industrial Chemical Laboratory.
2, 3.	{ Air, Water, and Food Analysis.	3.	General Bacteriology.
	{ Sugar Analysis.	4.	{ Assaying (additional).
4.	{ Industrial Chemical Laboratory.		{ Quantitative Analysis (additional).
	{ Sugar Analysis.	5.	{ Water Analysis.
5.	Differential Equations.		{ Electrical and Heat Measurements.

FOURTH YEAR.

FIRST TERM.		SECOND TERM.	
Organic Chemistry (lectures).		Organic Chemistry (lectures).	
Organic Analysis.		Gas Analysis.	
Organic Preparations and Reactions.		Chemical Equilibrium.	
Theoretical Chemistry.		Thermo and Electro-chemistry.	
Theoretical Chemical Laboratory. ¹		Electrical and Heat Measurements ²	
Elements of Non-ferrous Metallurgy. ¹		History of Chemistry.	
Metallurgy of Iron.		Thesis Reports.	
		Thesis.	
<i>Options.</i>		<i>Options.</i>	
1.	Valve-gears and Drawing.	1.	Engines and Machines.
2a.	Proximate Technical Analysis.	2.	Physico-chemical Laboratory.
2b.	Textile Colouring.	3.	{ Sanitary Science and Public Health.
3.	{ Bacteriology of Water and Sewage.		{ Microscopical Analysis of Water and Sewage.
	{ Industrial Biology.	4.	{ Non-ferrous Metallurgy.
4.	{ Non-ferrous Metallurgy.		{ Mining Machinery.
	{ Ore-dressing.	5.	{ Energetics.
	{ Laboratory Reports.		{ Physico-chemical Laboratory.
	{ Metallurgical Laboratory.		
5.	{ Electro-chemistry.		
	{ Kinetic Theory of Gases.		

¹ Omitted by students in Option 4.² Option 5, third year, second term.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

VI.—ELECTRICAL ENGINEERING.

SECOND YEAR.

FIRST TERM.	SECOND TERM.
Physics: Mechanics, Wave-motion Electricity (lectures).	Physics: Electricity, Optics (lectures).
Acoustics.	Physical Laboratory: Mechanics, Optics.
Principles of Mechanism.	Physical Measurements (lectures).
Mechanical Engineering Drawing.	Theoretical Electricity.
Differential Calculus.	Mechanism. Gear-teeth; Machine-tools.
Descriptive Geometry.	Mechanical Engineering Drawing.
Joinery and Pattern-work (or Metal-turning).	Integral Calculus.
German (or French).	Metal-turning (or Joinery and Pattern-work).
English Literature.	German (or French).
European History.	English Literature and Composition.

THIRD YEAR.

FIRST TERM.

Physics: Heat (lectures).
 Physical Laboratory: Heat.
 Theoretical Electricity.
 Dynamo-electric Machinery.
 Steam Engineering: Thermodynamics.
 Mechanical Engineering Drawing.
 Differential Equations.
 Statics; Stresses in Frames.
 German (or French).
 Political Economy.

SECOND TERM.

General Electrical Measurements.
 Electrical Engineering Laboratory.
 Periodic Currents.
 Electrical Measuring Instruments and Methods (lectures).
 Steam Engineering: Boilers.
 Engineering Laboratory.
 Drawing Design.
 Kinematics and Dynamics; Strength of Materials.
 German (or French).
 Political Economy and Industrial History.
 Business Law.

FOURTH YEAR.

FIRST TERM.

Theory of Periodic Currents.
 Direct Current Generators.
 Methods of Dynamo Testing.
 Storage Batteries and their Applications.
 Technical Photometry.
 Electrical Measuring Instruments and Testing (lectures).
 General Electrical Testing.
 Electrical Engineering Laboratory.
 Steam Engineering.
 Dynamics of Machines.
 Theoretical Hydraulics.
 Engineering Laboratory.
 Strength of Materials; Friction.

Options.

Railroad Signals.
 Propagation of Electric Waves.

SECOND TERM.

Theory of Alternating Current Machinery.
 Direct Current Practice.
 Alternating Current Practice.
 Telephony.
 Telephone Engineering.
 Principles of Dynamo Design.
 Electric Railroads.
 Electrical Engineering Laboratory.
 Engineering Laboratory.
 Economics of Corporations.
 Thesis.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

VII.—BIOLOGY.

SECOND YEAR.

FIRST TERM.

General Biology.
 Qualitative Analysis (lectures and laboratory).
 Mineralogy.
 General Geology.
 Physics: Mechanics, Wave-motion, Electricity (lectures).
 German (or French).
 English Literature.
 European History.

SECOND TERM.

Cryptogamic Botany.
 General Zoology.
 Quantitative Analysis (lectures and laboratory).
 Comparative Anatomy.
 Structural Geology.
 Physics: Electricity, Optics (lectures).
 German (or French).
 English Literature and Composition.

THIRD YEAR.

FIRST TERM.

Comparative Anatomy.
 Anthropology.
 Organic Chemistry (brief course).
 Air, Water, and Food Analysis.
 Structural Palæontology.
 Microscopic Anatomy.
 Physics: Heat.
 Physical Laboratory.
 German (or French).
 Political Economy.

SECOND TERM.

General Bacteriology.
 Microscopic Anatomy.
 Comparative Anatomy and Embryology.
 Theoretical Chemistry.
 Historical Geology.
 Physical Laboratory.
 German (or French).
 Political Economy and Industrial History.
 Business Law.

FOURTH YEAR.

FIRST TERM.

Comparative Physiology.
 Physiological Laboratory.
 Theoretical Biology.
 Microscopic Anatomy.
 Bacteriology of Water and Sewage.
 Industrial Biology.
 History of the Inductive Sciences.
 Journals.

Options.

1. Organic Chemistry.
2. { Mammalian Anatomy.
 Vertebrate Palæontology.
 Economic Biology.

SECOND TERM.

Sanitary Science and Public Health.
 Theoretical Biology.
 Comparative Physiology.
 Journals.
 Vital Statistics.
 Thesis.

Options.

1. { Microscopical Analysis of
 Water and Sewage.
 Municipal Sanitation.
- 2a. Descriptive Sociology.
- 2b. { Climatology, or
 Municipal Sanitation.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

VIII.—PHYSICS.

SECOND YEAR.

FIRST TERM.

Physics: Mechanics, Wave-motion, Electricity (lectures).
 Acoustics.
 Qualitative Analysis (lectures and laboratory).
 Descriptive Astronomy.
 Organic Chemistry (brief course).
 Differential Calculus.
 German (or French).
 English Literature.
 European History.

Options.

1. Qualitative Analysis (additional)
2. Determinants.

SECOND TERM.

Physics: Electricity, Optics (lectures).
 Physical Laboratory: Mechanics, Optics.
 Physical Measurements (lectures).
 Theoretical Electricity.
 Quantitative Analysis (lectures and laboratory).
 Theoretical Chemistry.
 Integral Calculus.
 German (or French).
 English Literature and Composition.

THIRD YEAR.

FIRST TERM.

Physics: Heat (lectures).
 Physical Laboratory: Heat.
 Theoretical Electricity.
 Elements of Industrial Electricity.
 Optical Measurements.
 Theoretical Chemistry.
 Method of Least Squares.
 German (or French).
 Political Economy.

Options.

1. { Quantitative Analysis.
 Differential Equations.
2. { Advanced Calculus and Geo-
 metry.
 Vector Analysis.

SECOND TERM.

Physical Laboratory (advanced).
 Electrical Measurements (laboratory).
 Electrical Measuring Instruments and Methods (lectures).
 Optical Measurements.
 Periodic Currents.
 Physico-chemical Laboratory.
 Chemical Equilibrium.
 Thermo-chemistry.
 Analytical Mechanics.
 German (or French).
 Political Economy and Industrial History.
 Business Law.

Options.

1. { Quantitative Analysis.
 or
 Electrical Engineering Laboratory and Advanced Physical Laboratory.
2. Differential Equations.

FOURTH YEAR.

FIRST TERM.

Electrical Testing: Heat Measurements.
 Theory of Periodic Currents.
 Electrical Measuring Instruments and Testing (lectures).
 General Theory of Light.
 Kinetic Theory of Gases.
 Electro-chemistry.
 Physical Colloquium.
 Fourier's Series; Laplace's Coefficients.
 History of Science.

Options.

1. Organic Chemistry.
2. Analytical Mechanics.

SECOND TERM.

Theory of Potential.
 General Theory of Light.
 Energetics.
 Fourier's Series; Laplace's Coefficients.
 Principles of Scientific Investigation.
 Physical Colloquium.
 Physical Research: Thesis.

Options.

1. Special Work: Chemistry or Physics.
2. Analytical Mechanics.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

VIII.—PHYSICS.

(Electro-Chemistry). ♦

SECOND YEAR.

FIRST TERM.

Physics: Mechanics, Wave-motion, Electricity (lectures).
 Qualitative Analysis (lectures and laboratory).
 Differential Calculus.
 Descriptive Geometry.
 Mechanical Engineering Drawing.
 Carpentry and Metal-turning.
 German (or French).
 English Literature.
 European History.

SECOND TERM.

Physics: Electricity, Optics (lectures).
 Physical Laboratory: Mechanics, Optics.
 Physical Measurements (lectures).
 Theoretical Electricity.
 Theoretical Chemistry.
 Quantitative Analysis (lectures and laboratory).
 Integral Calculus.
 German (or French).
 English Literature and Composition.

THIRD YEAR.

FIRST TERM.

Physics: Heat (lectures).
 Physical Laboratory: Heat.
 Theoretical Electricity.
 Dynamo-electric Machinery.
 Quantitative Analysis.
 Industrial Chemistry.
 Mineralogy.
 Differential Equations.
 Principles of Mechanism.
 German (or French).
 Political Economy.

SECOND TERM.

Electrical Measurements.
 Electrical Measuring Instruments
 and Methods (lectures).
 Periodic Currents.
 Electrical Engineering Laboratory.
 Theoretical Chemistry.
 Industrial Chemistry.
 Organic Chemistry.
 Assaying.
 Thermodynamics.
 Valve-gears.
 German (or French).
 Political Economy and Industrial
 History.
 Business Law.

FOURTH YEAR.

FIRST TERM.

Electro-chemistry (lectures).
 Electro-chemical Laboratory.
 Electrical Engineering: Direct
 Current Generators; Dynamo
 Testing (lectures).
 Electrical Testing; Electrical En-
 gineering Laboratory.
 Electrical Measuring Instruments
 and Testing (lectures).
 Theory of Periodic Currents.
 Heat Measurements.
 Theoretical Chemistry.
 Gas Analysis.
 Non-ferrous Metallurgy.
 Metallurgical Laboratory.
 Laboratory Reports.
 Physical Colloquium.

SECOND TERM.

Applied Electro-chemistry (lec-
 tures).
 Electro-chemical Laboratory.
 Electro-metallurgy.
 Theory of Alternating Current
 Machinery.
 Electrical Engineering: Direct
 Current Practice; Alternating
 Current Practice (lectures).
 Electrical Engineering Laboratory.
 Elements of Engineering.
 Chemical Equilibrium.
 Thermo-chemistry.
 Physical Colloquium.
 Thesis.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

IX.—GENERAL STUDIES (in process of revision).

SECOND YEAR.

FIRST TERM.

European History since 1815.
 History of England.
 Political Economy.
 Economic Problems.
 English Literature.
 French; German.
 General Biology.
 Physics: Mechanics, Wave-mo-
 tion, Electricity (lectures).

SECOND TERM.

History of England.
 English Literature and Composi-
 tion.
 French; German.
 Zoology and Botany.
 Structural Geology.
 Geological Field-work and Labora-
 tory.
 Physics: Electricity, Optics (lec-
 tures).
 Physical Laboratory.

THIRD YEAR.

FIRST TERM.

European Civilization and Art.
 English Composition (advanced course).
 Financial History of United States.
 Statistics of the United States.
 Anthropology.
 German, with sight-reading.
 Physics: Heat,
 or Industrial Electricity.

Options.

History of England in the 16th and 17th Centuries.
 Theories and Methods of Social Reform.
 English Literature to 1560.

SECOND TERM.

European Civilization and Art.
 History of Commerce.
 Descriptive Sociology.
 Historical Geology.
 Business Law.
 German, with sight-reading.

Options.

History of England in the 16th and 17th Centuries.
 Theories and Methods of Social Reform.
 English Literature: 1560-1660.
 French Literature.

FOURTH YEAR.

FIRST TERM.

Comparative Politics.
 International Law.
 Taxation and administration.
 English Literature: 1660-1780.
 Physiology and Personal Hygiene.

Options.

History of Era of French Revolution.
 History and Art of the Italian Renaissance.
 Municipal Government and Administration.
 Argumentation.
 Language: Special Work in French or German, or Elements of Spanish or Italian.

SECOND TERM.

Comparative Politics.
 History of Industry.
 History and Elements of Philosophy.
 English Literature: 1780-1860.
 Sanitary Science and Public Health.
 Climatology.
 Thesis.

Options.

History of Era of French Revolution.
 Municipal Government and Administration.
 Contemporary Literature.
 Journalism.
 Language: First Term continued.

X.—CHEMICAL ENGINEERING.

SECOND YEAR.

FIRST TERM.

Qualitative Analysis (lectures and laboratory).
 Principles of Mechanism.
 Differential Calculus.
 Physics: Mechanics, Wave-motion, Electricity (lectures).
 Descriptive Geometry.
 Carpentry and Wood-turning.
 German (or French).

SECOND TERM.

Quantitative Analysis (lectures and laboratory).
 Mechanism: Cotton Machinery; Machine-tools; Gear-teeth.
 Mechanical Engineering Drawing.
 Integral Calculus.
 Physics: Electricity, Optics (lectures).
 German (or French).

THIRD YEAR.

FIRST TERM.

Industrial Chemistry.
Organic Chemistry (brief course).
Steam Engineering; Thermodynamics.
Mechanical Engineering Drawing.
Elements of Differential Equations.
Physics: Heat.
Physical Laboratory.
Statics; Kinematics and Dynamics.
German (or French).
English Literature.
European History.

SECOND TERM.

Industrial Chemistry.
Industrial Chemical Laboratory.
Steam Engineering Boilers.
Drawing Design (or Boiler Drawing).
Engineering Laboratory.
Physical Laboratory.
Strength of Materials; Graphical Statics.
German (or French).
English Literature and Composition.

FOURTH YEAR.

FIRST TERM.

Applied Chemistry.
Testing of Oils.
Gas Analysis.
Chemical Resistance of Materials.¹
Steam Engineering.
Engineering Laboratory.
Industrial Electricity.
Metallurgy.
Strength of Materials; Friction.
Dynamics of Machines.
Political Economy.

Options.

1. Textile Colouring.
2. Heat Measurements.
3. Organic Chemical Laboratory.
4. Hydraulics and Hydraulic Measurements.
5. Machine Design.

SECOND TERM.

Applied Chemistry: Memoirs.
Technical Machinery.
Engineering Laboratory.
Strength and Stability of Structures; Theory of Elasticity.
Forging and Metal-turning.
Political Economy and Industrial History.
Business Law.
Thesis.

Options.

1. Applied Chemistry (additional).
2. Hydraulic Motors.
3. Theoretical Chemistry.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

¹ In place of Carpentry and Wood-turning after 1904.

XI.—SANITARY ENGINEERING.

SECOND YEAR.

FIRST TERM.

Surveying and Plotting.
Organic Chemistry (brief course).
General Geology.
Differential Calculus.
Spherical Trigonometry.
Physics: Mechanics, Wave-motion, Electricity (lectures).
Descriptive Geometry.
German (or French).
English Literature.
European History.

SECOND TERM.

Surveying and Plotting.
Topographical Drawing.
Qualitative Analysis (lectures and laboratory).
General Biology.
Structural Geology.
Integral Calculus.
Physics: Electricity, Optics (lectures).
German (or French).
English Literature and Composition.

THIRD YEAR.

FIRST TERM.

Railroad Engineering; Field-work and Drawing.
 Stereotomy.
 Advanced Surveying.
 Quantitative Analysis (lectures and laboratory).
 Micro Organisms.
 Topographical and Field Geology.
 Physics: Heat.
 Physical Laboratory.
 Statics; Stresses in Frames; Kinematics and Dynamics.
 German (or French).
 Political Economy.

SECOND TERM.

Railroad and Highway Engineering: Field-work and Drawing.
 Advanced Surveying.
 Theory of Structures.
 General Bacteriology.
 Physical Laboratory.
 Strength of Materials: Theory of Elasticity.
 German (or French).
 Political Economy and Industrial History.
 Business Law.

FOURTH YEAR.

FIRST TERM.

Theory of Structures; Bridges and Similar Structures.
 Theoretical Hydraulics.
 Hydraulic Measurements.
 Sanitary and Hydraulic Engineering.
 Bridge Design.
 Water Analysis.
 Bacteriology of Water and Sewage.
 Chemistry of Water and Sewage.
 Metallurgy of Iron.
 Industrial Electricity.
 Heating and Ventilation.
 Pipe-fitting.

SECOND TERM.

Theory of Structures; Bridges and Similar Structures.
 Hydraulic Engineering.
 Hydraulic Machinery.
 Sanitary and Hydraulic Design.
 Municipal Sanitation.
 Air Analysis.
 Sanitary Science and Public Health.
 Microscopical Analysis of Water and Sewage.
 Building Construction.
 Engineering Laboratory.
 Thesis.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

XII.—GEOLOGY.

SECOND YEAR.

FIRST TERM.

Physiography of the land.
 Mineralogy.
 General Geology.
 General Biology.
 Physics: Mechanics, Wave-motion, Electricity (lectures).
 Freehand Drawing.
 German (or French).
 English Literature.
 European History.

Options.

1. Qualitative Analysis (lectures and laboratory).
2. Surveying and Plotting.

SECOND TERM.

Mineralogy.
 Structural and Stratigraphical Geology.
 Geological Field-work and Laboratory.
 Zoology.
 Physics: Electricity, Optics (lectures).
 German (or French).
 English Literature and Composition.

Options.

1. Quantitative Analysis (lectures and laboratory).
2. { Surveying and Plotting.
 Topographical Drawing.
 Botany.

THIRD YEAR.

FIRST TERM.

Advanced Mineralogy.
 Chemical Geology and Ore-deposits.
 Economic Geology.
 Glacial Geology.
 Structural Palæontology.
 Anthropology.
 Physics: Heat.
 Physical Laboratory.
 German (or French).
 Political Economy.

Options.

1. Quantitative Analysis (lectures and laboratory).
2. { Advanced Surveying.
 { Geological Surveying.

SECOND TERM.

Petrography.
 Historical Geology.
 Physical Laboratory.
 German (or French).
 Political Economy and Industrial History.
 Business Law.

Options.

1. { Assaying.
 { Theoretical Chemistry.
2. { Advanced Surveying.
 { Geological Surveying.

ELECTIVE SUMMER COURSE OF FIELD-WORK IN ORE-DEPOSITS AND MINING (Option 1); STRATIGRAPHY AND PHYSIOGRAPHY (Option 2).

FOURTH YEAR.

FIRST TERM.

Experimental Geology.
 Chemical Geology and Ore-deposits.
 Economic Geology (metallic).
 Building Stones.
 Geological Field-Work and Laboratory.
 Physiography of the Sea.
 Stratigraphy of North America.
 Astronomy.

Options.

1. Mining Engineering and Metallurgy.
2. { Mining Engineering.
 { Hydraulic Measurements.
 { Areal Geology.

SECOND TERM.

Experimental Geology.
 Economic Geology (non-metallic).
 Economic Geology of North America.
 Physiography of North America.
 Applied Geology and Reports.
 Geological Field-work and Laboratory.
 Physiography of the Land.
 Palæontology.
 Climatology.
 Thesis.

Option.

1. Mining Engineering.

An elective course of field-work in Economic Geology may be taken during the semi-annual vacation of the fourth year.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

XIII.—NAVAL ARCHITECTURE.

SECOND YEAR.

FIRST TERM.

Principles of Mechanism.
 Mechanical Engineering; Drawing.
 Forging.
 Differential Calculus.
 Physics: Mechanics, Wave-motion, Electricity (lectures).
 Descriptive Geometry.
 German (or French).
 English Literature.
 European History.

SECOND TERM.

Mechanism: Gear-teeth; Machine-tools.
 Valve-gears.
 Mechanical Engineering Drawing.
 Forging, Chipping, and Filing.
 Integral Calculus.
 Physics: Electricity, Optics (lectures).
 German (or French).
 English Literature and Composition.

THIRD YEAR.

FIRST TERM.

Naval Architecture.
 Ship Construction.
 Naval Architectural Drawing.
 Drawing Design.
 Steam Engineering: Thermodynamics.
 Elements of Differential Equations.
 Physics: Heat.
 Physical Laboratory.
 Statics; Kinematics and Dynamics.
 German (or French).
 Political Economy.

SECOND TERM.

Naval Architecture.
 Naval Architectural Drawing.
 Steam Engineering: Boilers.
 Engineering Laboratory.
 Physical Laboratory.
 Strength of Materials; Graphical Statics.
 German (or French).
 Political Economy and Industrial History.
 Business Law.

FOURTH YEAR.

FIRST TERM.

Naval Architecture.
 Naval Architectural Drawing.
 Marine Engineering.
 Steam Engineering.
 Theoretical Hydraulics.
 Engineering Laboratory.
 Dynamics of Machines.
 Strength of Materials; Friction.
 Chipping and Filing; Machine-tool Work.
 Metallurgy of Iron.

SECOND TERM.

Naval Architecture.
 Naval Architectural Drawing.
 Marine Engineering.
 Engineering Laboratory.
 Strength and Stability of Structures; Theory of Elasticity.
 Machine-tool Work.
 Thesis.

Students entering after 1902 take German II. in their second year, and have no further requirement in modern languages.

XIII. A.—NAVAL ARCHITECTURE.

COURSE FOR NAVAL CONSTRUCTORS.

The three years of this Course correspond respectively to the third, fourth, and graduate years of Course XIII.

FIRST YEAR.

FIRST TERM.

Naval Architecture.
 Ship Construction.
 History of Modern Warship Design.
 Warship Design.
 Advanced Calculus and Geometry
 Least Squares.
 Theoretical Electricity.
 Hydraulics.
 Machine Drawing.
 Organic Chemistry.
 Heating and Ventilation.
 Spanish.

SECOND TERM.

Naval Architecture.
 Theory of Warship Design.
 Warship Design.
 Differential Equations.
 Strength of Materials: Graphical Statics.
 Chemical Laboratory.
 Physical Measurements (lectures).
 Physical Laboratory.
 Theoretical Electricity.
 Periodic Currents.
 Spanish.

SECOND YEAR.

FIRST TERM.

Naval Architecture.
Theory of Warship Design.
Warship Design.
Steam Engineering.
Drawing.
Strength of Materials: Friction.
Periodic Currents.
Heat Measurements.
Metallurgy of Iron.
Spanish.

SECOND TERM.

Naval Architecture.
Theory of Warship Design.
Warship Design.
Steam Engineering.
Strength and Stability of Structures: Theory of Elasticity.
Electrical Engineering.
Electrical Measurements.
Sanitation of Ships.
Foundations.
Metallography.
Spanish.

THIRD YEAR.

FIRST TERM.

Naval Architecture.
Theory of Warship Design.
Warship Design.
Marine Engineering.
Steam Engineering.
Dynamics of Machines.
Engineering Laboratory.
Theory of Structures.
Electrical Engineering.
Electrical Testing.
Electrical Engineering Laboratory.

SECOND TERM.

Naval Architecture.
Theory of Warship Design.
Warship Design.
Marine Engineering.
Electrical Engineering.
Electrical Engineering Laboratory.
Engineering Laboratory.
Business Law.
Thesis.

REQUIREMENTS FOR GRADUATION.

The degree of Bachelor of Science, in the course pursued, is given for the satisfactory completion of any of the regular courses of study.

To be entitled to a degree, the student must have attended the Institute for not less than one year next preceding his graduation, must have completed the prescribed studies and exercises of the four years, and must, in addition, pass final examinations, if required, on subjects relating particularly to his course. He must, moreover, prepare a dissertation on some subject included in his course of study; or an account of some research made by himself; or an original report upon some machine, work of engineering, industrial works, mine or mineral survey; or an original design accompanied by an explanatory memoir. This thesis or design must be approved by the Faculty. Theses are to be written on one side only of paper of good quality, $8 \times 10\frac{1}{2}$ inches in size, with an inch margin on the inner edge, and a half-inch margin on the outer edges.

GRADUATE COURSES.

The Institute offers courses of advanced study and research leading to the degrees of Master of Science, Doctor of Philosophy, and Doctor of Engineering.

An applicant for any of these degrees must, except in cases of unusual attainment, have taken his first degree in some scientific school, college, or university of good standing; and his attainments must be substantially equivalent to those required for the Bachelor's degree of the Massachusetts Institute of Technology.

MASTER OF SCIENCE.

The course of study leading to the degree of Master of Science must consist mainly of advanced study and research in the branch of science or engineering in which the student has already completed an undergraduate course. The candidate must pursue his course of study continuously, under the direction and oversight of the Faculty, for at least one full school year after filing his application, exhibiting during that time ability to conduct original investigations. He must pass creditable examinations at such times and on such subjects as may be designated, and finally must present an acceptable thesis.

The following definite schedules of graduate courses have been adopted by the Faculty, but are presented as typical, and not as prescribed courses. Course XIII.A also leads to the Master's degree.

III. G.—MINING ENGINEERING AND METALLURGY.

GRADUATE COURSE.—(*Option I.*)

FIRST TERM.	SECOND TERM.
Principles of Mechanism. ¹	Mechanism.
Steam Engineering.	Steam Engineering.
Drawing.	Drawing.
Electrical and Heat Measurements. ²	<i>Option A.</i>
Electrical Engineering (lectures).	Advanced Surveying.
Electrical Engineering (laboratory).	Railroad Drawing and Field-work.
<i>Option A.</i>	Theory of Structures.
Advanced Surveying.	Ore-dressing Laboratory; Thesis.
Railroad Drawing and Field-work.	<i>Option B.</i>
Theory of Structures. ³	Electro-metallurgy.
Ore-dressing (reading).	Metallurgical and Chemical Laboratory; Thesis.
<i>Option B.</i>	Gas Analysis.
Electro-chemistry.	Distillation of Fuels.
Electro-chemical Laboratory.	Forging.
Metallography (lectures; laboratory.)	

¹ Descriptive Geometry must have been completed.

² Option A omits heat measurements.

³ Structures must have been completed.

IV. G.—ARCHITECTURE.

GRADUATE COURSE.

FIRST TERM.	SECOND TERM.
History and Art of the Italian Renaissance. ¹	Advanced Architectural Design ; Thesis.
Advanced Architectural Design.	Philosophy of Art (lectures). ²
Advanced Composition: Theory and Practice.	History and Archæology ; Special Research.
Advanced Constructive Design.	Advanced Decorative Design ; Life Class.
Building Laws and Contracts.	Composition in Rendering ; Theory and Practice.
Advanced Decorative Design ; Life Class.	
Composition in Rendering ; Theory and Practice.	
Æsthetics.	

¹ The History of Greek and Roman Civilization and Art is given in the fourth year.

² The History of Ornament is given in the fourth year.

Opportunity will be offered also for graduate work in architectural engineering and landscape architecture.

V. G.—CHEMISTRY.

GRADUATE COURSE.

FIRST TERM:	SECOND TERM.
Advanced Inorganic Chemistry.	Advanced Inorganic Chemistry
Advanced Theoretical Chemistry.	Qualitative Analysis of Rare Metals, or
Chemical Research.	Organic Qualitative Analysis.
<i>Option A.</i>	Chemical Research.
Electrical Engineering (lectures).	<i>Option A.</i>
Electrical Engineering (laboratory)	Advanced Industrial Chemistry.
Principles of Mechanism.	Mechanism.
Statics ; Kinematics and Dynamics.	Drawing Design.
{ Steam Engineering or	Strength of Materials ; Graphical Statics.
{ Drawing.	Steam Engineering.
<i>Option B.</i>	Drawing Design.
Electro-chemistry (lectures).	Engineering Laboratory.
Electro-chemistry (laboratory)	<i>Option B.</i>
Kinetic Theory of Gases.	Electricity.
Method of Least Squares.	Applications of Polarized Light.
Differential Equations.	Energetics.
	Advanced Calculus.

VI. G.—ELECTRICAL ENGINEERING.

GRADUATE COURSE.

FIRST TERM.

Theoretical Electricity: Theory of Transmission Lines.
 Laboratory of Electrical Measurements: Electrical Testing.
 Laboratory of Electrical Engineering: Advanced Direct and Alternating Current Work.
 Design of Stations and Distribution Systems.
 Dynamo Design.
 Heat Measurements.
 Strength of Materials.
 Drawing and Machine Design.
 Electro-chemistry.
 Fourier's Series.

SECOND TERM.

Theoretical Electricity: Theory of Transmission Lines.
 Laboratory of Electrical Engineering: Polyphase Work.
 Design of Stations and Distribution Systems.
 Specifications and Contracts.
 Machine Design.
 Fourier's Series.
 Thesis.

XIII. G.—NAVAL ARCHITECTURE.

GRADUATE COURSE.¹

Naval Architecture.
 Warship Design.
 Theory of Warship Design.
 Differential Equations.
 Advanced Calculus.
 Theoretical Electricity.²
 Industrial Electricity.
 General Electrical Testing.
 Methods of Dynamo Testing.
 Electrical Measuring Instruments and Testing.
 Electrical Engineering Laboratory.

Naval Architecture.
 Warship Design.
 Theory of Warship Design.
 Sanitation of Ships.
 Theoretical Electricity.
 Periodic Currents.
 Electrical Measuring Instruments and Methods.
 Electrical Engineering Laboratory.
 Methods of Dynamo Testing.

¹ For graduates of Course XIII. who desire Warship Design. The former graduate Course C is now offered as a basis for the Bachelor's degree.

² Applicants for this course must have taken Theoretical Electricity, or the equivalent.

DOCTOR OF PHILOSOPHY.

The degree, Doctor of Philosophy, certifies to the creditable completion of an advanced course of study in some branch of science and to the performance of an original research of high grade bearing upon some scientific topic. It will be awarded only to candidates who have exhibited the power of attacking new problems in an independent and efficient manner. The study and research for the degree must be pursued under the direction and oversight of the Faculty for not less than two school-years.

The candidate for the degree submits for the approval of the Faculty the course of study which he desires to pursue. This must consist mainly of research, but must also comprise

a considerable amount of advanced study. Besides taking the subjects specified in his course of study, the candidate will be expected to prepare himself in a broad way upon certain branches of science: thus a student specializing in physics would be required to pass a general examination upon that science and upon one or more related sciences, like chemistry or mathematics.

DOCTOR OF ENGINEERING.

The degree, Doctor of Engineering, certifies to the creditable completion of an advanced course of study in some branch of engineering, and to the performance of an original research of high grade bearing upon some engineering topic. Candidates for this degree must be registered in the Graduate School of Engineering Research and work under the direction of its Council for a period of at least two years.

RESEARCH LABORATORIES.

RESEARCH LABORATORY OF PHYSICAL CHEMISTRY.

The Institute has just established a laboratory of physical chemistry, to be opened in September, 1903, which is to be devoted exclusively to research work in that subject. It will be equipped with every convenience for physico-chemical investigations.

A number of advanced lecture courses will be offered by members of the Research Laboratory staff, and seminar meetings will be conducted. These may be attended by all those engaged in the research work, including the advanced students.

SANITARY RESEARCH LABORATORY AND SEWAGE EXPERIMENT STATION.

By the generosity of an anonymous donor the Institute has recently been enabled to establish a station provided with facilities for demonstration of the more important methods employed on a large and a small scale for the purification of sewage and water, and in connection therewith well-equipped sanitary chemical and bacteriological laboratories. The site of the laboratory borders upon one of the largest of the trunk sewers of the Boston main drainage system, and with this sewer connections have been made, so that raw sewage may be pumped in abundance at any hour of the day or night, as may be required for demonstrations or experiments. The equipment of the station, together with the chemical and bacteriological laboratories in a small building adjoining, furnishes, it is believed, exceptional facilities, such as are provided by few other educational institutions, if any, for work of this character bearing upon sanitary biology, sanitary chemistry, and sanitary engineering.

GRADUATE SCHOOL OF ENGINEERING RESEARCH.

A graduate school of engineering research will be established as a distinct department of the Institute immediately after the opening of the next academic year; *i.e.*, on Oct. 7, 1903. Courses for 1903-4 will be offered by the Departments of Civil, Mechanical, Mining, Electrical, Chemical, and Sanitary Engineering and Naval Architecture, with the co-operation of the Departments of Mathematics, Physics, Chemistry, Biology, &c.

Four fellowships of \$500 each will be available for the beginning of the year 1903-4, and holders of these fellowships will be exempt from tuition fees. Candidates for admission will in general be expected to have such training as is represented by the degree of Bachelor of Science of the Massachusetts Institute of Technology or other institutions of corresponding grade. The degree of Doctor of Engineering will be conferred for satisfactory resident work occupying not less than two years. A fee of \$25 will be required, and an additional fee of \$25 for each full course of thirty hours of class work or sixty hours of laboratory work, but the maximum charge for instruction will be \$250 for the year.

SUMMER COURSES.

During the summer vacation, after the close of the school year, the Institute offers systematic instruction in a considerable range of studies. The courses offered during the summer of 1903 include mechanical drawing and descriptive geometry; analytic geometry; integral calculus; applied mechanics; analytical and inorganic chemistry; air, water, and food analysis; organic chemistry; organic analysis and preparations; industrial chemistry; physics, including mechanics, light, electricity, heat and physical laboratory; electrical testing; surveying; mechanism and mechanical engineering drawing; assaying; shades and shadows; elementary architectural design; sanitary and industrial bacteriology; research in bacteriology and public health; mechanic arts, including woodwork, forging, chipping and filing, and machine-tool work; European history since 1815; and French and German. Applications for other courses will be entertained. The work offered is planned with particular reference to subsequent study at the Institute. It enables students to anticipate portions of the work of the succeeding year, or to remove deficiencies in any work of the previous year which, through sickness or other cause, they have failed to complete at the proper time. Again, persons desiring to enter with advanced standing—in particular, college graduates—may make up, in the summer courses, deficiencies which might otherwise cause serious embarrassment in their choice of studies and arrangement of hours for the year.

The Institute also maintains professional summer schools, devoted mainly to field-work in mining engineering, surveying, geology, hydraulic engineering, and architecture.

REQUIREMENTS FOR ADMISSION.

Applicants for admission to the Massachusetts Institute of Technology are, in general, required to pass entrance examinations. Application for exception will be entertained by the Faculty, however, in the case of persons who present satisfactory certificates of the College Entrance Examination Board, or of entrance examinations passed at another college. Such certificates must cover not less than three of the subjects required by the Institute. Persons who are past the usual age or who are engaged in teaching or technical pursuits, and applicants who for satisfactory reasons desire only special courses requiring no previous training—as, for example, mechanic arts and drawing—may be admitted also, at the discretion of the Faculty, without entrance examinations.

The following table shows which records of the College Entrance Examination Board will be accepted as covering requirements for admission to the Institute:—

M. I. T. SUBJECTS.	C. E. E. B. SUBJECTS.
ALGEBRA.	MATHEMATICS <i>a</i> (Elementary Algebra).
ENGLISH.	ENGLISH <i>a</i> and <i>b</i> .
FRENCH.	FRENCH <i>a</i> (Elementary).
GEOMETRY, PLANE.	MATHEMATICS <i>c</i> (Plane Geometry).
GEOMETRY, SOLID.	MATHEMATICS <i>d</i> (Solid Geometry).
GERMAN.	GERMAN <i>a</i> (Elementary).
HISTORY.	HISTORY <i>a</i> or <i>d</i> .
ELECTIVE.	HISTORY <i>b</i> or <i>c</i> , LATIN <i>a</i> and <i>b</i> (or equivalent), FRENCH <i>b</i> , GERMAN <i>b</i> , PHYSICS, or CHEMISTRY.

Records below 60 will not be accepted.

French *b* and German *b* will be accepted for advanced standing.

Certificates.—The Institute accepts no certificates of preparatory schools in place of entrance examinations. The value of the opinion of previous teachers is, however, fully recognised, and great weight will be attached to statements from them. It is accordingly requested that every applicant present from the principal of the school last attended a statement of the duration and extent of his work there.

SUBJECTS FOR EXAMINATION.

To be admitted as a regular student in the first-year class, the applicant must have attained the age of seventeen years, and must have passed satisfactory examinations in the following subjects:—

ALGEBRA.	FRENCH I.
PLANE GEOMETRY.	GERMAN I.
SOLID GEOMETRY.	ENGLISH.
	HISTORY.

He must also present satisfactory evidence of preparation in one of the following Electives :—

FRENCH or GERMAN (addi-	PHYSICS.
tional).	CHEMISTRY.
LATIN.	MECHANICAL DRAWING and
ENGLISH (additional).	MECHANIC ARTS.
HISTORY (additional).	

Physics will be transferred to the list of required subjects for admission in 1905 and thereafter.

BUILDINGS AND LABORATORIES.

Mechanic Arts.—The carpentry, wood-turning, and pattern-making laboratories contain forty carpenter's benches, two circular-saw benches, a swing-saw, two jig-saws, a buzz-planer, thirty-six wood-lathes, a large pattern-maker's lathe, and thirty-six pattern-maker's benches. The founding laboratory contains a cupola furnace for melting iron, two brass furnaces, a core oven, and thirty-two moulder's benches. The forging laboratory contains a power-hammer, thirty-two forges, seven blacksmiths' vices, one blacksmith's hand-drill, and a power-shear. The machine-tool laboratory contains twenty-three engine-lathes and seventeen hand-lathes of approved pattern, a twenty-four-inch turret-lathe, two machine-drills, three planers, a shaping-machine, two universal milling-machines furnished with spiral and gear-cutting attachments, a plain milling-machine, a universal grinding-machine, a cutter and reamer grinder, a twenty-four-inch standard measuring machine, thirty-two vice benches arranged for instruction in vice-work, special apparatus for hardening and tempering, and a fully equipped tool-room.

Chemistry.—The facilities for gas analysis have recently been increased by the enlargement of the rooms devoted to this work and by the addition of much new apparatus. New laboratories have also been equipped for the chemical and physical testing of oils and for the optical and chemical examination of sugars, starches, &c.

The Kidder Laboratories of Chemistry afford accommodations for more than nine hundred students. The Chemical Department occupies twenty-five laboratories, three lecture-rooms, a reading-room and library, three balance-rooms, offices, and supply-rooms—in all forty-five rooms. Five new laboratories have been recently added for advanced work and research. The laboratory for inorganic chemistry has places for six hundred students, and is completely equipped for instruction in elementary chemistry. The analytical laboratories can accommodate two hundred students, and possess every

convenience for accurate and rapid analytical work. The main organic laboratory has places for thirty-six students, and is provided with appliances for vacuum, steam and fractional distillation, with suction pumps for filtration, with electrolysis circuits, filter-presses, &c. Adjoining it is a laboratory arranged for organic combustions, and on the roof is an enclosed room, in which chemical operations of a dangerous or noxious character can be performed. The laboratory of water, air, and food analysis contains places for sixteen students, and possesses a complete outfit for the analysis of air and water, and for the investigation of sanitary problems. The laboratories of industrial chemistry accommodate forty-eight students. They comprise a series of rooms in the Pierce Building fitted with the needful apparatus for the preparation of chemicals on a considerable scale. The main laboratory contains kettles of various patterns, stills, presses, tanks, centrifugal dryers, crystal dryers, a filter-press, a furnace, and a variety of other forms of apparatus. The laboratory devoted to textile colouring contains numerous jacketed kettles, baths, and dye-tubs, squeeze-rolls, a steamer, an ager, and a dryer. The laboratory for oil and gas analysis accommodates thirty-six students and is equipped, for the examination of gases, with thirty-three sets of gas-absorption and explosion apparatus, with sampling apparatus, flue thermometers, a photometer, and a gas calorimeter. For the analysis of oils, the laboratory is provided with viscosimeters, testing machines, different sorts of flash-point apparatus, and other instruments employed in this special line of work. There are also special laboratories for instruction in proximate technical analysis, in molecular weight determinations, and in sugar analysis. The main lecture hall has a seating capacity of three hundred, and is arranged with special reference to the delivery of lectures illustrated by experiment.

In addition there are two lecture-rooms, seating respectively forty-eight and one hundred and twenty-five students. The lecture-rooms contain valuable cabinets of specimens for purposes of illustration. The balance-rooms are supplied with thirty analytical balances.

The William Ripley Nichols Chemical Library, numbering more than eight thousand volumes and sixteen hundred pamphlets, is kept in the reading-room of the department. This library, which is open to all students, contains complete sets of most of the important chemical periodicals and a noteworthy collection of works upon sanitary science. The number of periodicals currently received is about one hundred and seventy-five.

Physics.—The Rogers Laboratory of Physics is located in the Walker Building, and occupies sixteen rooms. Of these, two are lecture-rooms: the general physical lecture-room, seating three hundred and fifty students; and a smaller lecture-room for special lectures in physics and chemistry, seating one hundred. Both of these are fitted with appliances for physical

experimentation and for the use of the lantern. The Rogers Laboratory has an exceedingly extensive equipment of apparatus for both demonstration and physical measurements, and large additions are made to it every year.

The several laboratories are as follows :—

The Laboratory of General Physics, which is devoted to instruction in general physical measurements, including mechanics of solids, liquids and gases, light and heat. The equipment consists entirely of instruments of a high grade, and corresponding precision is required in the work of the student.

For advanced work, provision is made in the following special laboratories :—(1) the Electrical Laboratory; (2) the Physico-chemical Laboratory; (3) the Electro-chemical Laboratory; (4) the Laboratory of Heat Measurements; (5) the Laboratory of Acoustics; (6) the Optical Laboratory.

Provision is made for research in all the special laboratories.

The library of the department contains seven thousand volumes, and is very complete in recent works upon physics and electricity. All new publications of importance are procured upon their issue. The principal physical and electrical periodicals are received regularly, seventy-nine such being taken.

Electrical Engineering.—*The Augustus Lowell Laboratories of Electrical Engineering.*—These laboratories embrace the Standardizing Laboratory, the Laboratory of Dynamo-electric Machinery, and various rooms devoted to photometric measurements and to special research.

The Standardizing Laboratory furnishes facilities for making tests and for giving instruction in the measurements arising in technical work. It is provided with circuits furnishing alternating current at 25 and 60 cycles, both three-phase and quarter-phase, and also direct current. The equipment is of such a nature that any proposed scheme of measurement may be subjected to careful investigation. To this end the apparatus for standardization is very complete. For direct currents a storage battery giving 1,000 amperes is provided, together with a special set of high-voltage dynamos, giving potentials to 3,000 volts. To complete this set of apparatus, there are the necessary controlling devices, together with standard ammeters, voltmeters, and a potentiometer reading to 1,500 volts. By means of special transformers, alternating currents up to 4,000 amperes and potentials to 50,000 volts can be obtained. The necessary auxiliary apparatus for controlling and measuring these currents and potentials is provided. For the standardization of devices for power-measurement there is a set of two small machines so arranged that the instruments can be tested under various conditions as regards power-factor and frequency. Several oscillographs of different designs are provided for the examination of wave-forms. These are so arranged as to be readily portable, and are available for any

tests carried on in the department. The laboratory is provided with sets of standard resistances, certified by the Reichsanstalt, all necessary apparatus for measuring both high and low resistances and for calibrating resistance boxes, and also with standards of capacity and inductance, with the necessary auxiliary apparatus.

The Laboratory of Dynamo-electric Machinery is equipped with a complete electric lighting and power plant available for testing purposes, as well as a very extensive collection of alternating and direct current machinery. The power plant consists in part of a battery of two 250-horse-power Babcock and Wilcox boilers, built for a working pressure of 250 lbs., but running normally at 160 lbs., with foundations and space provided for three boilers; a 750-horse-power, horizontal, cross-compound Russell engine, direct-connected to a 480-kilowatt, double-current General Electric generator; and a 250-horse power, horizontal, tandem-compound Ridgeway engine, direct-connected to a 230-volt, 60-cycle, four-phase General Electric alternator. These engines exhaust into a Worthington surface-condenser, provided with steam-driven air and circulating pumps. The circulating water is cooled by a Worthington cooling tower. The condensed steam from the engine is purified and returned to the boiler through a Cochrane feed water-heater. The output of these generators is delivered to a large switchboard of modern construction, from which light and power feeders are taken, and connections are made to the special mains about the laboratory.

The equipment includes also two 75-kilowatt, 230-volt, three-wire Westinghouse generators, each connected to a 125-horse-power Westinghouse compound engine; a special testing set, consisting of two similar 25-kilowatt General Electric generators belted to a 100-horse-power Westinghouse compound engine, this set being specially fitted with electrical instruments, engine-indicating apparatus, and surface-condenser for instruction in various methods of plant-testing; a motor-generator set, consisting of a 150-horse-power, 230-volt, direct current motor, driving a 100-kilowatt, 230-volt, 60-cycle, three-phase generator and a 50-kilowatt, 230-volt, 25-cycle, three-phase generator; a motor-driven pair of series-boosters suitable for raising the potential of an 800-ampere, three-wire feeder 10 per cent.; a 100-kilowatt set of 60-cycle phasing transformers for change from three-phase to two-phase, or the reverse; a 50-kilowatt, 25-cycle rotary transformer, having compounded field-windings with a variable reactance, provided with screw adjustments, giving a maximum reactance of 50 per cent. of the rotary capacity, together with a field rheostat, a speed-limiting device, circuit-breakers, a starting compensator, and a neutral connection from the transformers, so that this combination can be used as commercially installed, for central-station, railway, power, or lighting service; a 150-horse-power direct current motor, and a 100-horse-power Westinghouse standard engine, to be used on the testing floor for supplying

power to any generators undergoing special study; two 30-horse-power, one 20-horse-power, and two 15-horse-power, 230-volt, direct current motors; and two 15-kilowatt, 60-cycle, three-phase machines, which can be operated at any frequency between 25 and 75 cycles per second, and can be used as generators or synchronous motors. There is a similar though somewhat smaller pair of 25-cycle machines; a number of induction motors from 30-horse-power down; a 2-kilowatt, alternating current generator, capable of giving any frequency up to 10,000 cycles; a 12-kilowatt Edison generator; a $13\frac{1}{2}$ -kilowatt, Thomson-Houston, inclined-coil generator; a 20-kilowatt Westinghouse compound generator; a United States 40-kilowatt compound generator; a 30-kilowatt, 1100-volt, single-phase, Thomson-Houston alternating current generator, with transformers of various patterns and designs; a 37-kilowatt, Mordey inductor, 1100-volt, alternating current generator; a Brush 30-arc-light generator; an experimental 15-kilowatt, 440-volt, three-phase generator, with Scott transformers of 10-kilowatt capacity; a 25-cycle set, illustrating the problems of long distance transmission, consisting of three 30-kilowatt, 25-cycle, step-up transformers; a single 55-kilowatt, three-phase transformer, with a 145-volt secondary; three 20-kilowatt, 60-cycle, and four 15-kilowatt, 60-cycle, transformers of standard voltages for general use about the laboratory; a pair of 60-cycle testing transformers, stepping up from 230 volts to 100,000 volts; and a 10-ton, electrically-driven, overhead crane, which traverses the entire length of the laboratory. There is also a large number of direct current dynamos and motors, alternating current dynamos and transformers, under 10-horse-power capacity, together with inductances and condensers. The ventilating fans of the building and the fan for the cooling tower are driven by one 15-horse-power and two 10-horse-power motors, especially arranged for such work, and are available for instruction in connection with electrically-driven, variable-speed fans.

Of the four dark rooms provided, one is equipped with a special photometer, designed by the department, for use in testing arc lights; one for special testing; and one as a photographic room, with ample accommodations for developing, printing, and washing.

The laboratory possesses a large and representative collection of arc lamps, suitable for use on alternate and direct current circuits, both constant potential and constant current.

The shop of the department is well supplied with machine tools, among which are a 24-inch planer, with a six-foot bed, two gear-cutting engine lathes, an emery grinder, two speed-lathes, a precision lathe with milling attachment, and an up-right drill.

The highest importance is attached to work in the nature of scientific research; and special rooms, together with ample facilities in the nature of apparatus, are available.

Civil Engineering.—An observatory in the Middlesex Fells, within easy access of Boston, is devoted to instruction in geodesy and astronomy. It is a stone building, fifteen feet square, and contains at present the following apparatus : a transit instrument of $2\frac{1}{2}$ -inch aperture, 27-inch focus, with micrometer eye-piece for latitude observations ; a sidereal chronometer, a chronograph, a magnetometer, a dip circle, an altazimuth instrument, and various other smaller appliances, such as level triers ; mercury horizons, &c. This observatory enables the Institute to offer the best facilities for instruction in geodesy.

The instruments and apparatus of the department may be classified as follows :—a full outfit of instruments used in surveying and in the drawing-room ; a collection of hydraulic apparatus for work in the field, comprising single and double floats of various patterns, loaded tubes, and five current meters of different kinds ; apparatus for comparing the wearing properties and other physical characteristics of the various road and pavement materials ; and continuous-record instruments for measuring the strain in bridges and other structures of metal ; a very complete hydraulic apparatus for the measurement of the flow of water through orifices and mouth-pieces, over weirs, through pipes, &c.

The department has also a collection of models illustrating bridge-details, problems in stone-cutting, &c., and a set of full-sized models of various types of road and pavement construction, for use in connection with the work of instruction.

The Engineering Laboratories.—These laboratories are situated in the building on Trinity Place, where they occupy a floor-space of about 21,000 square feet.

The Applied Mechanics Laboratory is furnished with the following apparatus : a testing-machine of one hundred thousand pounds capacity and another of fifty thousand pounds capacity for determining tensile strength, elasticity, and compressive strength ; a testing-machine of one hundred thousand pounds capacity for determining the transverse strength and stiffness of beams up to twenty-five feet in length, of framing-joints used in practice, and of other structures subjected to a transverse load ; a testing-machine of eighteen thousand pounds capacity for determining the transverse strength and stiffness of beams up to fourteen feet in length ; apparatus of thirty thousand pounds capacity for making time-tests of full-sized timber beams ; a kiln for drying lumber ; apparatus for testing the strength of full-sized masonry arches ; a machine for testing the torsional strength and stiffness of shafting up to three inches in diameter and to twenty-one feet in length ; a torsion machine of sixty thousand inch-pounds capacity ; a small torsion machine of six thousand inch-pounds capacity, for very delicate work ; machinery for the measurement of the twist of shafting ; for testing the tensile strength of mortars and cements, and of ropes ; for testing the effect of repeated stresses upon the elasticity and strength of iron and steel ; for determining the strength and elasticity of wire ; for determining the

strength and elasticity of cloth ; for testing the strength of pipe and pipe-fittings under hydraulic pressure ; and also accessory apparatus for measuring stretch, deflection and twist. Besides the above-stated apparatus, a horizontal Emery testing-machine of three hundred thousand pounds capacity forms a part of the equipment of this laboratory. It contains all the essential features of the eight hundred thousand pound testing-machine built by Lieutenant Albert H. Emery at the Watertown arsenal, and is suitable for testing a compression specimen eighteen feet long, and a tension specimen twelve feet long.

The Hydraulic Laboratory contains a closed steel tank five feet in diameter and over twenty-seven feet high, arranged for the insertion of orifices, mouth-pieces, and other special pieces of apparatus, with gates for controlling the discharge, and with connections for supplying water, in experiments upon pipes and motors. This tank is connected with a ten-inch stand-pipe over seventy feet high, so arranged that a constant head may be maintained at any desired level. Two steel tanks, each of about two hundred and eighty cubic feet capacity, give opportunity for the accurate measurement of larger quantities of water than can be weighed directly during experiments. A system of pipes connected both with the main tank and with the pumps is arranged for the insertion of diaphragms, branches, and other apparatus for studying loss of head and the laws of discharge. An attachment has been fitted to the main tank, containing a Pitot tube for studying the laws of velocity in jets, and adjustable points for accurate measurement of the cross-section of jets.

The laboratory is further equipped with a forty-eight inch Pelton wheel, of thirty horse-power ; a three-foot American impulse wheel ; a Venturi meter ; an eight-inch, a twelve-inch, and two forty-eight inch weirs, and an orifice tank for measuring water ; a centrifugal pump ; a rotary pump ; a plunger pump ; a pulsometer ; a three-inch water meter and others of smaller size, and a variety of mercury gauges, standard orifices, mouth-pieces, diaphragms, branches, nozzles, &c., for experiments with flowing water under all conditions. A six-inch turbine is arranged to be run under various conditions of head and gate opening in tests for efficiency. There is also a hydraulic ram with a two-and-one-half-inch drive-pipe. The laboratory also contains a steel weir-box, the weir having a standard crest adjustable as to length from zero to five feet, and a seconds pendulum, with chronograph for exact determination of time in experimental work. Water is directly supplied for experiment by the various pumps.

The Steam Laboratory contains a triple-expansion engine, with cylinders of nine inches, sixteen inches, and twenty-four inches diameter respectively, and thirty inches stroke, arranged in such a way as to be run single, compound, or triple, as desired for purposes of experiment. This engine is of the Corliss type, and has a capacity of about one hundred and fifty horse-power when running triple, with an initial pressure of

one hundred and fifty pounds in the high-pressure cylinder. It is connected with a surface condenser and the other apparatus necessary to adapt it to the purposes of accurate experiment. A tandem compound, high-speed engine of about two hundred and twenty-five horse-power, having cylinders eleven and nineteen inches in diameter by fifteen inches stroke, is similarly provided with surface condenser, air pump, and other apparatus needed for testing. This engine transmits its power through a rope drive.

This laboratory also contains a three-stage air-compressor adapted to compress one hundred cubic feet of free air per minute to twenty-five hundred pounds pressure per square inch, connected with storage tubes of about fifty-eight cubic feet capacity; a sixteen horse-power engine, and an eight horse-power engine, used for giving instruction in valve setting, &c., also a thirty-six horse-power gas-engine, and a small gas-engine. It is equipped with several surface condensers, steam-pumps, injectors and ejectors, calorimeters, mercurial pressure and vacuum columns; apparatus for determining the quantity of steam or air issuing from a given orifice or through a short tube under a given difference of pressure; apparatus for testing steam-engine indicators; apparatus for testing injectors; and indicators, planimeters, gauges, thermometers, anemometers, and other accessory apparatus.

The Engineering Laboratories are provided with a number of friction brakes; with machinery for determining the tension required in a belt or rope to enable it to carry a given power at a given speed, with no more than a given amount of slip; with four transmission dynamometers; with two machines for determining the coefficient of friction of lubricating oils; with a pendulum governor arranged for experimental purposes; with a complete set of Westinghouse air-brake apparatus, including the parts belonging to the car and to the locomotive; with the pump and engineer's valve of the New York air-brake; with a locomotive link model; with two hot-air engines; and with cotton machinery as follows:—two cards, a drawing-frame, a speeder, a fly-frame, a ring spinning-frame, and a mule, as well as accessory apparatus. There are available for purposes of experiment in connection with the work of these laboratories four horizontal tubular boilers in a boiler-house near the Engineering building, with a wrought-iron stack, three feet in diameter and one hundred feet high, fitted with the apparatus necessary to make experiments on the draughts of chimneys; two large sectional boilers situated in the Rogers Building with a masonry stack three feet square and one hundred feet high; and also another boiler, a forty horse-power engine, a number of looms, and other apparatus in the mechanical laboratories on Garrison-street.

The Engineering Library.—The libraries of the Departments of Civil, Mechanical, and Sanitary Engineering, and Naval Architecture are united into a single library under the direct charge of the Librarian of the Institute. This library

contains over ten thousand volumes and four thousand pamphlets. It is especially rich in journals and transactions of societies dealing with the various branches of engineering and ship-building. One hundred and ninety-seven publications of this kind are received annually.

Mining Engineering and Metallurgy: The John Cummings Laboratories of Mining Engineering and Metallurgy.—These laboratories are designed to furnish students the means for experimental study of the various processes of ore-dressing and smelting, and at the same time to give them the mental training needful for professional practice. The apparatus has been chosen with a view to illustrating, as far as possible, the principles of the more important machines and furnaces actually used in mines, mills, and smelting works.

The crushing, concentration, and smelting of ores of lead, copper, gold, and silver furnish the best field for this laboratory work. The production of iron and steel in quantity is precluded by the size of the plant required, and by the large amount of ores and fluxes needed; the microscopical study of the structural changes that occur under heat treatment takes its place.

The laboratories include five parts: concentration and plate amalgamation, roasting and smelting, lixiviation and pau amalgamation, assaying, and heat treatment and microscopical examination of metals and alloys.

The Biological Laboratories comprise four well-equipped laboratories for undergraduates, with smaller rooms for special lines of work, and a laboratory devoted to more advanced or special investigation. In connection with these there is a well-appointed library and reading-room, centrally placed, and containing more than two thousand volumes and monographs.

A large laboratory of general biology and microscopy supplies the needs of classes in these subjects, as well as of those in elementary zoology and botany.

A second laboratory, somewhat smaller, furnishes opportunities for the practical work of the classes in comparative anatomy, embryology, cryptogamic botany, and histology. It is equipped with Thoma and Minot microtomes, paraffin baths, microscopes, and reagents for work on the gross and microscopic anatomy of plants and animals.

For experimental work in physiology there is a special laboratory equipped with continuous roll and drum kymographs, induction coils, and other electrical apparatus, moist chambers, tambours, plethysmographs, &c., for physiological measurements, and with desks for work in physiological chemistry. Adjoining this is a workshop, with lathe and tools, as well as a dark-room for work in physiological optics.

The laboratory of bacteriology and industrial and sanitary biology is supplied with microscopes, incubating chambers, thermostats, and other special appliances necessary for the

detailed and practical study of micro-organisms. In connection with it there is a special culture-room and a room for chemical work and the preparation of nutrient media.

Finally, there is a research laboratory for the use of graduate students and special investigators. This is fitted with thermostats, autoclaves, and other apparatus for the study of problems connected especially with the sanitary and industrial applications of biology.

The Geological and Mineralogical Laboratories.—The laboratory of mineralogy is so equipped as to be convenient, both as a class-room and as a laboratory for descriptive and determinative mineralogy, and contains collections of minerals arranged for class work in these subjects. The tables in this room have been specially designed for work in blow-pipe analysis. Here also is placed a machine for the cutting and polishing of mineral and rock sections.

The laboratory of structural geology (petrography) contains, first, a cabinet collection of rocks, and an extensive series of trays especially arranged for the laboratory work in lithology; second, an exceptionally complete petrographic collection; third, a cabinet collection of minerals; fourth, the crystallographic illustrations, including both models and natural crystals; and, fifth, all the facilities for the work in petrography.

ELECTRO-CHEMICAL LABORATORY.

BENCH EQUIPMENT FOR EACH STUDENT.

Bench for each student, 6 feet by 2 feet 3 inches wide; usual height.

I.

(1.) Small switchboard—

12½ volt circuit.

25 " "

110 " "

(2.) Small motor.

(3.) Thermostat bath.

(4.) Power shaft, turned by motor.

II.

Electrical Measuring Instruments.

1 Weston milli voltmeter and shunt.

1 Weston 3-scale voltmeter.

1 Lippman electrometer.

1 Potential box.

1 Large rheostat.

1 Copper voltameter.

- 1 Soluble anode voltameter, with two double connectors and platinum and silver electrodes.
- 1 Gas voltameter.
- 1 Slide wire bridge.
- 1 Induction coil.
- 1 Telephone.
- 1 Conductivity cell with platinum electrodes and stand.

III.

Other Electro-Chemical Apparatus.

- 1 Transference apparatus with two double connectors, one silver and one platinum electrode, and stand.
- 1 Contact key.
- 1 "Normal" electrode with stand.
- 2 "Half" electrodes with stands.
- 1 Small glass cylinder.
- 1 Platinum electrode (2 sq. cm.).
- 1 " " (loop).
- 2 Silver "
- 1 Zinc "
- 1 Copper "
- 3 Electrolysis stands (each different).
- 1 H tube and stand.
- 5 Double connectors.

REGULATIONS.

The Status of Students in regard to scholarship and ability to continue their courses is determined in part by means of examinations; but regularity of attendance and faithfulness to daily duties are considered equally essential.

Examinations.—General examinations are held each year in January and in May; but examinations in fourth-year subjects finished before the end of the term may be held at the close of the respective courses.

Fees.—The tuition fee for regular students is \$250 per year, and must be paid *in advance* as follows:—\$150 on or before October 10, and \$100 on or before February 20. No bills are sent in advance for the *first* term. For one-half or any less fraction of the school year, the fee is \$150. Payment is required also for chemicals used and for apparatus injured or destroyed in the laboratories, and for the cost of repair of damage by students to any other property of the Institute. Special students pay, in general the full fee; but when a few

branches only are pursued, and the time required for instruction is limited, application for reduction may be made to the Bursar. The fee for students in graduate courses is the same as that for regular students.

Residence and Expenses.—The cost of board and rooms in Boston and the neighbouring cities and towns need not exceed seven or eight dollars a week. The cost of books, drawing instruments, paper, &c., exclusive of chemical breakage, is from twenty-five to thirty-five dollars a year.

Conduct.—It is assumed that students come to the Institute for a serious purpose, and that they will cheerfully conform to such regulations as may be from time to time made by the Faculty. In case of injury to the building, or to any of the furniture, apparatus, or other property of the Institute, the damage will be charged to the student or students known to be immediately concerned; but, if the persons who caused the damage are unknown, the cost of repairing the same may be assessed equally upon all the students of the school.

It is the aim of the Faculty so to administer the discipline of the school as to maintain a high standard of integrity and a scrupulous regard for truth. The attempt of any student to present as his own any work which he has not performed, or to pass any examination by improper means, is regarded by the Faculty as a most serious offence, and renders the offender liable to immediate expulsion. The aiding and abetting of a student in any dishonesty is also held to be a grave breach of discipline.

MASSACHUSETTS SCHOOL OF DESIGN.

The Massachusetts School of Design is based on the reorganization of the Lowell School of Practical Design, established in 1872 by the Trustee of the Lowell Institute for the purpose of promoting industrial art in the United States. The Corporation of the Massachusetts Institute of Technology has conducted the Lowell School of Design in accordance with the purpose and general plan of the school, as proposed by the Trustee of the Lowell Institute; and the same relation is maintained with the new school.

Requirements for Admission.—To teach drawing is not among the objects of this school. Applicants must therefore possess a knowledge of drawing adequate to enable them advantageously to begin the work of composition and design. Applicants must be sixteen years of age.

The tuition fee will be \$100 per annum, paid \$50 in advance and \$50 at the beginning of the second term.

 COURSE IN DESIGN.

FIRST YEAR (Flat Ornament).

FIRST TERM.

Drawing and Colouring from Copy.
 Designing Geometric Ornament.
 Analysis of Elemental Patterns.
 Planning of Ornament.

SECOND TERM.

Analysis of Colour.
 Designing Simple Ornament in Historic Styles: Repeats, etc.
 Application of Simple Ornament to Prints, Textiles, etc.
 History of Ornament.

SECOND YEAR.

FIRST TERM.

Development of Ornament.
 Adaptation to Special Forms and Materials:
 Textiles, Prints, Carpets, Wall Papers, Woven Materials, Inlays, Mosaics, etc.
 History of Arts in which Ornaments are used, and their Application.
 Drawing from Object.

SECOND TERM.

Development and Application of Ornament.
 Painted Ceramics.
 Book Bindings.
 Embossing.
 Illuminating.
 Lettering.
 Stained Glass.
 Embroidery, Laces, etc.
 Metal work.
 Cloisonnés, etc.
 Development of Colour.
 Modelled Ornament.
 Turned Forms.
 History of Industrial Art.

THIRD YEAR.

FIRST TERM.

Study of Architectural Mouldings and Forms.
 Moulding: Low and High Relief.
 Metal Work.
 Gold, Silver, and Bronze.
 Gas Fixtures.
 Woven Fabrics.
 Damasks, etc.
 Embossed Leathers.

SECOND TERM.

Introduction of Figures into Design.
 Furniture and Interior Fittings.
 History of Industrial Arts.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

STUDENT'S REPORT OF SUMMER READING, 1903.

*This list to be filled out and returned to the Registrar's Office
not later than October 10.*

REQUIRED LIST FOR FIRST-YEAR STUDENTS.

History.

- FROUDE, J. A. : English Seamen in the Sixteenth Century.
 MACAULAY, T. B. : History of England : Vol. I., Chap. 3. (Also
 published separately under the title, "England in 1685.")
 DE QUINCEY, T. : Joan of Arc.

Poetry.

- SHAKESPEARE, W. : Hamlet or Othello.
 PALGRAVE, F. T. : The Golden Treasury. Selections. (See
 below.)

Essays.

- CARLYLE, T. : Heroes and Hero Worship. Lecture II.
 EMERSON, R. W. : The American Scholar.

Fiction.

- STEVENSON, R. L. : Kidnapped.
 SCOTT, W. : Quentin Durward.
 BULWER-LYTTON, E. L. : The Last Days of Pompeii.

Science.

- TYNDALL, J. : On the Scientific Use of the Imagination.
 TYLOR, E. B. : Anthropology—An Introduction to the Study of
 Man and Civilization.

Selections from the Golden Treasury.

XLV. Fidele. LI. Cupid and Campaspe. LV. This life,
 which seems so fair. LVI. Soul and Body. LXIII. Song for
 Saint Cecilia's Day, 1687. LXVII. On the Tombs in West-
 minster Abbey. LXIX. Death the Leveller. LXXI. On His
 Blindness. LXXIII. The Noble Nature. LXXXIII. To
 Lucasta, on Going to the Wars. CI. Encouragements to a
 Lover. CIII. The Manly Heart. CX. To Daffodils. CXII.
 L'Allegro. CXIII. Il Penseroso. CXVI. Alexander's Feast.
 CXLI. The Passions. CXLVII. Elegy Written in a Country
 Churchyard. CL. O, my Love's like a red, red rose. CLI.
 Highland Mary. CLII. Auld Robin Gray. CLVII. The Land

o' the Leal. CLXV. Life! I know not what thou art. CLXXXI. Lord Ullin's Daughter. CLXXXII. Jock o' Hazel-dean. CCV. A wet sheet and a flowing sea. CCVII. Battle of the Baltic. CCXV. Hohenlinden. CCXVI. After Blenheim. CCXVIII. The Burial of Sir John Moore. CCXXIV. Past and Present. CCXXV. The Light of Other Days. CCXXIX. The Mermaid Tavern. CCXXXI. The Bridge of Sighs. CCXLI. To a Skylark. CCXLVI. Ozymandias of Egypt. CCL. The Highland Reaper. CCLIII. The Daffodils. CCLV. Ode to Autumn. CCLXXXVIII. The World is too much with us. CCLXXXVIII. Ode on Intimations of Immortality.

REQUIRED LIST FOR SECOND-YEAR STUDENTS.

History.

FISKE, J. : The Critical Period of American History.
 MORRIS, W. O., *or* ROPES, J. C. : Napoleon.
 GIBBINS, H. DE B. : The Industrial History of England.

Fiction.

THACKERAY, W. M. : Henry Esmond, *or* GEORGE ELIOT, Romola.

The scene of "Henry Esmond" is laid in England in the early part of the eighteenth century. Several historical characters are introduced; and the plot deals in part with political intrigues. The novel is considered one of the greatest ever written, the character-drawing being especially fine.—The scene of "Romola" is laid in Florence in the last years of the fifteenth century. Savonarola and other historical personages are introduced. The story is interesting; and the book is especially valuable as a picture of the times.

BRYANT, W. C. : The Iliad of Homer. Books I., VI., X., XVI., XVIII., XIX., XXII., XXIII., XXIV. Also the summaries of the omitted books, so that the story may be followed. (In the Students' Edition these summaries are given in the table of Contents.)

Also one of the first five works of fiction given in the Supplementary List.

Science.

HUXLEY, T. H. : The Advance of Science in the Last Half Century.

TYNDALL, J. : Faraday as a Discoverer; *or* THOMPSON, S. P., Michael Faraday, His Life and Work. (The latter work is considerably longer.)

MARSHALL, A. M. : Lectures on the Darwinian Theory.

NEWCOMB, S. : Astronomy for Everybody; *or* YOUNG, C. A. : The Sun.

SUPPLEMENTARY LIST.

Fiction.

HAWTHORNE, NATHANIEL : The House of the Seven Gables.

Scene in Salem in the early part of the last century. Delicate romance, with exquisite pictures of life in provincial New England.

READE, CHARLES : The Cloister and the Hearth.

Scene in Holland in latter half of fifteenth century. Story (partly fictitious) of parents of Erasmus. A strong novel, of great historical interest.

KINGSLEY, CHARLES : Westward Ho !

Romance of England and of the Spanish Main in the time of Elizabeth. Fine picture of the more romantic side of the spirit of the sixteenth century. In part the story is historical. Sir Richard Grenville, Drake, and others are introduced. This novel may well be read in connection with Froude's "English Seamen."

DICKENS, CHARLES : A Tale of Two Cities.

A story of the French Revolution, with effective pictures of the times. The tale itself is both exciting and touching.

SCOTT, WALTER : The Heart of Midlothian.

A partly historical romance of Scotland in the first half of the eighteenth century. A touching and absorbing tale.

DICKENS, CHARLES : The Cricket on the Hearth.

KINGSLEY, CHARLES : Hypatia.

THACKERAY, W. M. ; Pendennis.

ELIOT, GEORGE : Adam Bede.

HUGO, VICTOR : Les Misérables.

BALZAC, HONORÉ DE (Miss Wormeley's translation) : The Chouans. Modeste Mignon.

DUMAS, A., *père* : The Three Guardsmen.

GASKELL, MRS. : Mary Barton.

The preceding works are standard novels, chosen as representative and as particularly adapted to this list. The following are entertaining books, not all of especial literary merit, but worth reading for one reason or another.

STEVENSON, R. L. : Treasure Island.

David Balfour.

KIPLING, RUDYARD : Life's Handicap.

Soldiers Three.

The Jungle Books.

CABLE, G. W. : Old Creole Days.

Q. : The Splendid Spur.

The Blue Pavilions.

MITCHELL, S. W. : Hugh Wynne.

BROWN, MISS ALICE : King's End.

PAGE, T. N. : In Ole Virginia.

CRAWFORD, F. MARION : A Roman Singer.

Saracinesca.

WILKINS, MISS MARY E. : A Humble Romance.

DAVIS, MRS. M. E. M. : In War Times at La Rose Blanche.

JEWETT, MISS SARAH ORNE : Country of the Pointed Firs.

MASON, A. E. W. : The Four Feathers.

History; Biography of Statesmen.

- PARKMAN, F. : The Jesuits in North America.
 La Salle and the Discovery of the Great West.
 Montcalm and Wolfe.
 Conspiracy of Pontiac.
- FISKE, J. : The Discovery of America.
 The Beginnings of New England.
 The American Revolution.
- MOTLEY, J. L. : The Rise of the Dutch Republic.
- GREEN, J. R. (Editor) : Readings from English History.
- MOMBERT, J. I. : A Short History of the Crusades.
- SCHURZ, CARL : Henry Clay.*
- MORSE, J. T. : Thomas Jefferson.*
 Abraham Lincoln.*
- HOSMER, J. K. : Samuel Adams.*
- LORD ROSEBURY : William Pitt.†
- MORLEY, JOHN : Chatham.†
 Walpole.†
 Burke.
- SMITH, GOLDWIN : Three English Statesmen.
- HARRISON, F. : Cromwell.†

Politics.

- BRYCE, JAMES : Impressions of South Africa.
- MORRIS, CHARLES : Our Island Empire.
- GOODNOW, F. J. : Municipal Problems.
- PORRITT, E. : The Englishman at Home.
- SHAW, A. : Municipal Government in Great Britain.
- WELLS, D. A. : Recent Economic Changes.
- WILCOX, D. F. : Study of City Government.
- PARSONS, W. B. : An American Engineer in China.

Science.

- LANGLEY, S. : The New Astronomy ; or CLERKE, MISS A. M. :
 The System of the Stars ; or BALL, R. S. : Story of the
 Heavens.
- NEWCOMB, SIMON : The Stars ; A Study of the Universe.
- BALL, SIR R. S. : Time and Tide.
- CLERKE, MISS A. M. : History of Astronomy during the Nine-
 teenth Century.
- BALL, W. W. R. : A Primer of the History of Mathematics.
- TYNDALL, J. : Fragments of Science.
- RAMSAY, W. : Gases of the Atmosphere.
- HELMHOLTZ, H. VON : Popular Scientific Lectures.
- TAIT, P. G. : Recent Advances in Physical Science.
- CAJORI, F. : A History of Physics.
- WILLIAMS, H. S. : The Story of Nineteenth Century Science.
- THOMPSON, S. P. : Light, Visible and Invisible.
- LUBBOCK, J. : The Scenery of Switzerland.
- HUXLEY, T. H. : Discourses Biological and Geological.
 Physiography : an Introduction to the Study
 of Nature.

* American Statesmen Series.

† Twelve English Statesmen Series.

RUSSELL, I. C. : Glaciers of North America.
Lakes of North America.
Volcanoes.

THOMSON, J. A. : Study of Animal Life.

WALLACE, A. R. : Darwinism.

DARWIN, C. : Insectivorous Plants.

Formation of Vegetable Mould through the
Action of Worms.

WOODHEAD, G. S. : Bacteria and Their Products.

McKENDRICK AND SNODGRASS : Physiology of the Senses.

Biography of Scientific Men.

AGASSIZ, MRS. E. C. : Louis Agassiz.

THORPE, T. E. : Essays in Historical Chemistry.

MUIR, PATTISON : Heroes of Science : Chemists.

CLERKE, MISS A. M. : The Herschels and Modern Astronomy.

BREWSTER, SIR DAVID : Life of Sir Isaac Newton.

ROGERS, MRS. E. : Life and Letters of William Barton Rogers.

GLAZEBROOK, R. T. : James Clerk Maxwell.

FRANKLIN, BENJAMIN : Autobiography.

VALLERY-RADOT : Life of Louis Pasteur.

HUXLEY, LEONARD : Life and Letters of Thomas Henry
Huxley.

Engineering.

HARCOURT, L. F. VERNON : Achievements in Engineering.

NASMYTH, JAMES : Autobiography.

SMILES, S. : Lives of George and Robert Stephenson, and of
Boulton and Watt, in "Lives of the Engineers."

CHURCH, W. C. : Life of John Ericsson.

VOSE, G. L. ; Loammi Baldwin.

Art and Artists.

BROWN, HORATIO : Venetian Sketches.

Life on the Lagoons.

STATHAM : Architecture for General Readers.

CLEMENT, MRS. C. E. : Italian Painters.

OLIPHANT, MRS. : The Makers of Venice.

The Makers of Florence.

GRIMM, H. : Michel Angelo. Raphael.

RICHTER, J. P. : Leonardo da Vinci.

Travel.

PARKMAN, FRANCIS : The Oregon Trail.

WHYMPER, EDWARD : Travels amongst the Great Andes of the
Equator.

DE AMICIS : Holland.

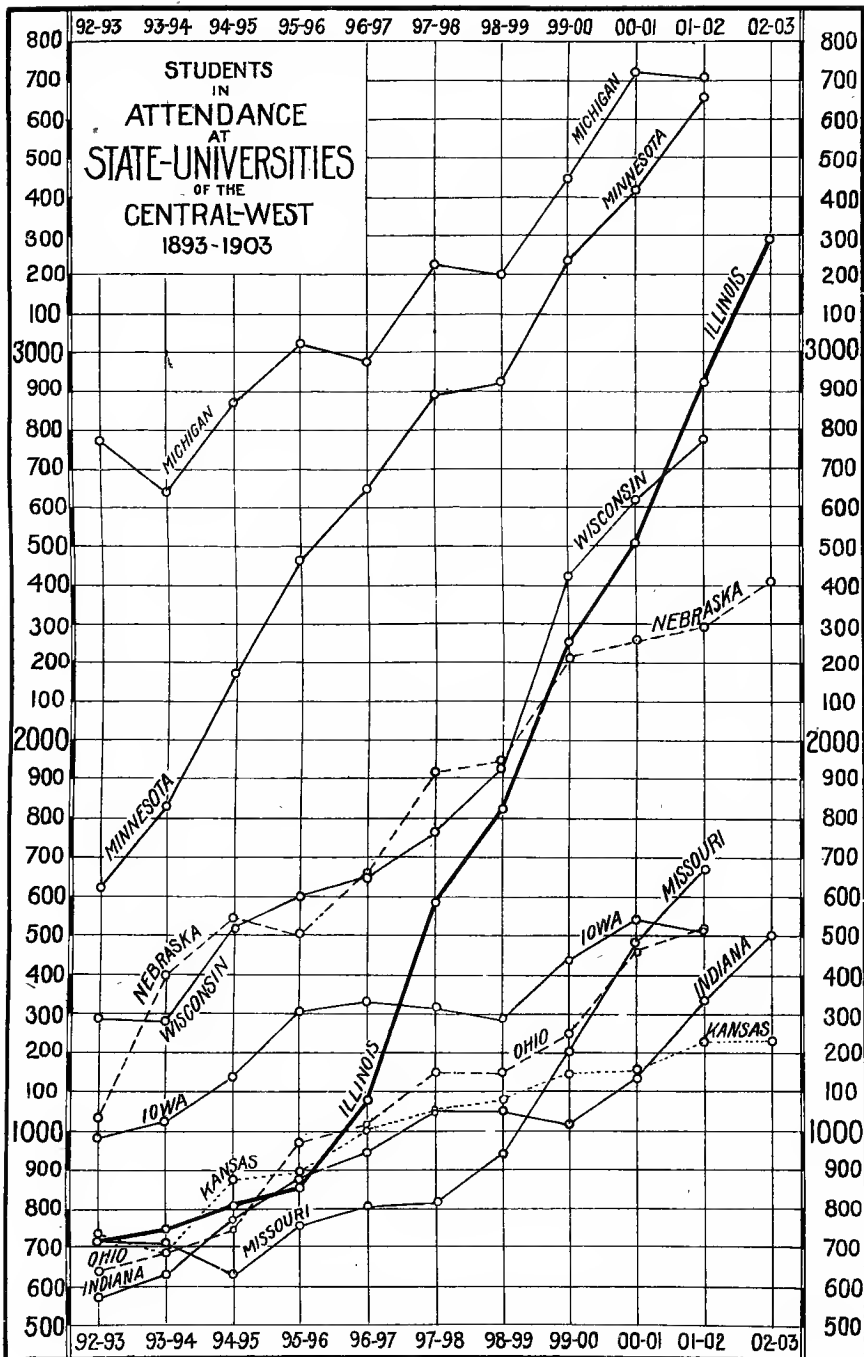
BORROW, GEORGE : The Bible in Spain.

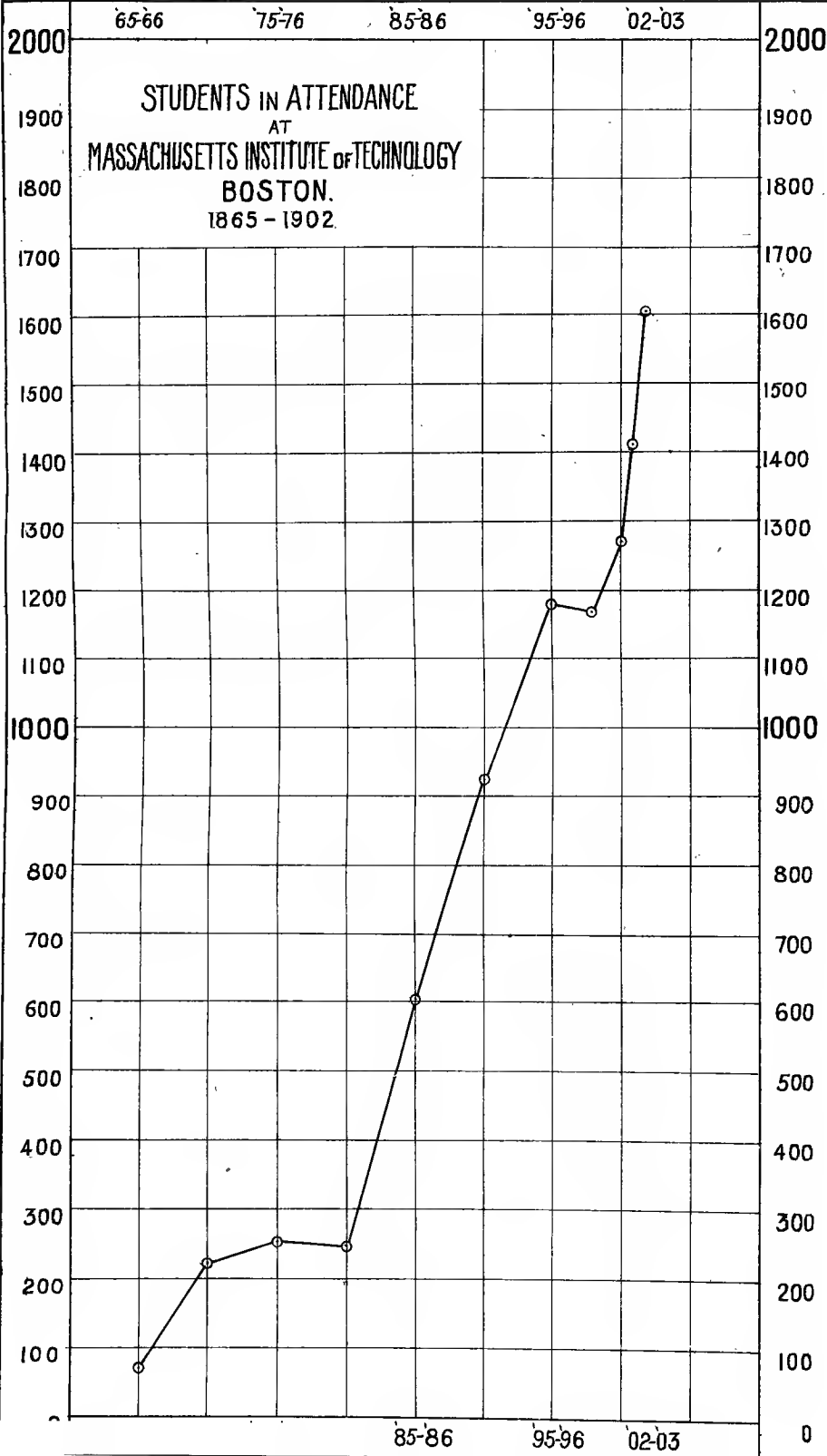
I have read during the preceding summer the works marked with a
cross (+) in the above lists. I had previously read those marked with a
double cross (‡‡)

(Signature).....

Class of.....

STUDENTS
IN
ATTENDANCE
AT
STATE-UNIVERSITIES
OF THE
CENTRAL-WEST
1893-1903







UNIVERSITY OF ILLINOIS.

Buildings and Grounds.

The land occupied by the university and its several departments embraces about 210 acres.

The Chemical Laboratory is a three-storey building, the ground plan of which is shaped like the letter E. The extreme dimensions are 230 feet along the front and 116 feet along the wings. The middle rear wing contains the lecture amphitheatre, which will seat 350. The end wings contain the large general laboratories. The central part of the building is occupied by offices, museum, class and seminary rooms, supply rooms, &c., and a number of special rooms for research work. There is a well-lighted basement, which contains the heating and ventilating plant, and rooms for assaying and metallurgy.

The Engineering Hall has a frontage of 200 feet, a depth of 76 feet on the wings, and 138 feet in the centre. The first storey contains the laboratories of the department of physics, the drafting seminary, and one of the recitation rooms of the department of electrical engineering, and the masonry laboratories and instrument rooms of the department of civil engineering. The second storey contains the lecture room and the preparation rooms of the department of physics, the recitation and drawing rooms, cabinets, and studies of the departments of civil and municipal engineering, and the main office of the department of electrical engineering. The third storey contains the elementary laboratory of the department of physics, the drawing rooms, lecture rooms, cabinets, and studies of the mechanical departments, as well as the library, the office, and the faculty parlour. The fourth storey is devoted to the department of architecture, and contains drawing and lecture rooms, cabinets, a photograph studio, and a blue-print laboratory.

The Wood Shop is a brick building in the form of a cross, one portion being about 200 by 46 feet, one storey high, while the other part is 52 by 80 feet and two storeys high. This shop contains the bench room, lathe room, machine room, lecture room, exhibition room, tool room, office, and room for pattern storage and repair work.

The Metal Shops are in a one-storey brick building, 50 by 250 feet. It contains a lecture room, two office rooms, a machine shop, a foundry, and a forge shop. The machine shop is 48 by 140 feet. Power is supplied by a 20-h.p. electric motor. A three-ton travelling crane of 12-foot span covers the centre of the floor for the entire length, extending over a covered driveway between the machine shop and foundry.

The Mechanical and Electrical Engineering Laboratory is a brick building, two storeys high, 100 feet long, and 50 feet wide, with a one-storey wing 90 feet long and 50 feet wide. There is a basement under the main part, containing some special testing rooms, store rooms, and the toilet and wash rooms.

The Laboratory of Applied Mechanics is a brick building. The materials testing laboratory occupies the front, 45 by 65 feet, while the rear wing, 45 by 106 feet, contains the hydraulic laboratory.

THE PENNSYLVANIA STATE COLLEGE.

ENGAGEMENTS ON COMPLETION OF COLLEGE COURSES.

Graduates from the technical courses of the Pennsylvania State College at the last commencement, June 17, 1903, have at this date, July 1st (within two weeks after graduation), secured desirable positions, many having made their engagements before receiving their diplomas.

The list is as follows :—

COURSE IN CHEMISTRY.

- Hugh J. Boyle, of Hazleton, with the Alen-Wood Iron and Steel Company, Conshohocken, Pa.
 Joseph F. Bradley, of Harrisburg, with the Pennsylvania Steel Company, Steelton, Pa.
 Harry G. German, of North Wales, with the Keystone Powder Company, Emporium, Pa.
 George O. Gray, of State College, with the Allegheny Ore and Iron Company, Iron Gate, Va.
 Frank Monahan, of Titusville, with the Carnegie Steel Company, Duquesne, Pa.
 *Arthur S. O'Neill, of Warren.
 *Carl W. Rogers, of Warren.

COURSE IN CIVIL ENGINEERING.

- Donald C. Baird, of Lock Haven, rodman with the Pennsylvania Railroad, Osceola Mills, Pa.
 Edward S. Frey, of York, with the city engineer, York, Pa.
 *George B. Hoke, of Bismarck.
 Robert M. Huber, of St. Thomas, with the P. C. C. & St. L. Ry. Co., Chicago, Ill.
 Edwin H. May, of Renovo, rodman on the South West System of the Pennsylvania Lines, Allegheny, Pa.
 Simon E. Miller, of Lancaster, draughtsman with the American Bridge Company, Philadelphia, Pa.
 Isaac C. Palmer, of Manito, draughtsman with the American Bridge Company, Pittsburg, Pa.
 Frederick R. Shaffer, of Bellwood, transitman with the Webster Coal and Coke Company, Cresson, Pa.
 Ellis C. Silvius, of Sunbury, rodman with the Pennsylvania Railroad Co., Altoona, Pa.
 Ezekiel Sterrett, of Falls Creek, with W. G. Wilkins & Co., Sykesville, Pa.
 Harry E. Stitt, of Blairsville, with Heyl & Patterson, Pittsburg, Pa.
 Lawrence C. Walsh, of Duquesne, draughtsman with Riter-Conley Mfg. Co., Pittsburg, Pa.

COURSE IN ELECTRICAL ENGINEERING.

- Elmer H. Beckert, of Pittsburg, in the student course of the General Electric Company, Schenectady, N.Y.
- John C. Clendenin, of Mechanicsburg, in the student course of the General Electric Company, Lynn, Mass.
- Arthur R. Dennington, of Deckard, holder of the John W. White Fellowship—Instructor in Electrical Engineering, State College, Pa.
- Harry A. Eisenhuth, of Selinsgrove, in the student course of the General Electric Company, Schenectady, N.Y.
- Edgar E. Godard, of Huntingdon, in the student course of the General Electric Company, Schenectady, N.Y.
- Francis C. Johnston, of Franklin, with J. G. White & Company, electrical contractors, Manila, Philippine Islands.
- David A. Jones, jr., of Minersville, in the student course of the General Electric Company, Schenectady, N.Y.
- *Charles L. Kinsloe, of Lock Haven.
- Walter L. Kirk, of Pittsburg, with the Montana Electric Transmission Company, Helena, Montana.
- James V. Kyle, of Milroy, with the signal department of the Pennsylvania Railroad Company, Pittsburg, Pa.
- John B. Landis, of Rock Glenn, with the American Car and Foundry Company, Berwick, Pa.
- Ernest S. McLarn, of Oakdale, in the student course of the Western Electric Company, Chicago, Ill.
- William R. Miles, of Kennett Square, with the Montana Electric Transmission Company, Helena, Montana.
- Joseph M. Nelson, of Chester, with J. G. White & Company, Electrical Contractors, 29, Broadway, New York City, N.Y.
- Frank L. Rohrbach, of Sunbury, in the student course of the General Electric Company, Schenectady, N.Y.
- Ralph M. Rumbel, of Ringtown, in the student course of the Western Electric Company, Chicago, Ill.
- *Bayard H. Sharpe, of West Chester.
- Emory B. Stauffer, of Palo Alto, in the student course of the General Electric Company, Lynn, Mass.
- Harry E. Stoeltzing, of Pleasantville, in the student course of the Western Electric Company, Chicago, Ill.
- Clarence G. Stoll, of Mount Joy, in the student course of the Western Electric Company, Chicago, Ill.
- Howard S. Yeakle, of Norristown, with the signal department of the Pennsylvania Railroad Company, Pittsburg, Pa.

COURSE IN MECHANICAL ENGINEERING.

- Robert R. Baillie, of Millersburg, with the steam turbine department of the General Electric Company, Schenectady, N.Y.
- Edmund D. Campbell, of Beach Haven, with the American Car and Foundry Company, Berwick, Pa.
- John S. Cochran, of Lancaster, with the Lancaster *Daily Examiner*, Lancaster, Pa.

- Ralph L. Cummings, of Cape May, N.J., with the Allis-Chalmers Company, Milwaukee, Wis.
- John R. Decker, of Zion, with the Michigan Central Railroad Company, Detroit, Mich.
- Sterling D. Fowler, of Berwick, with the American Car and Foundry Company, Berwick, Pa.
- Ralph V. Little, of Cumberland, Md., with the Druar Contracting Company, Buffalo, N.Y.
- William A. Merkel, of Berwick, with the American Car and Foundry Company, Berwick, Pa.
- Edwin R. Norris, of North East, with the Lackawanna Steel Company, Buffalo, N.Y.
- Charles M. Parker, of Lewistown, with the Armstrong Cork Company, Pittsburg, Pa.
- Ernest G. Rogers, of Warren, with the Newport News Dry Dock and Ship Building Company, Newport News, Va.
- Percy M. Snoeberger, of Martinsburg, with the B. F. Sturtevant Company, Philadelphia, Pa.
- John H. Snyder, of Broughton, with the American Steel and Wire Company, Pittsburg, Pa.
- Paul V. Stevenson, of Pittsburg, with the B. F. Sturtevant Company, Philadelphia, Pa.
- Robert L. Streeter, of Medix Run, Instructor in Mechanical Engineering, State College, Pa.

COURSE IN MINES AND MINING.

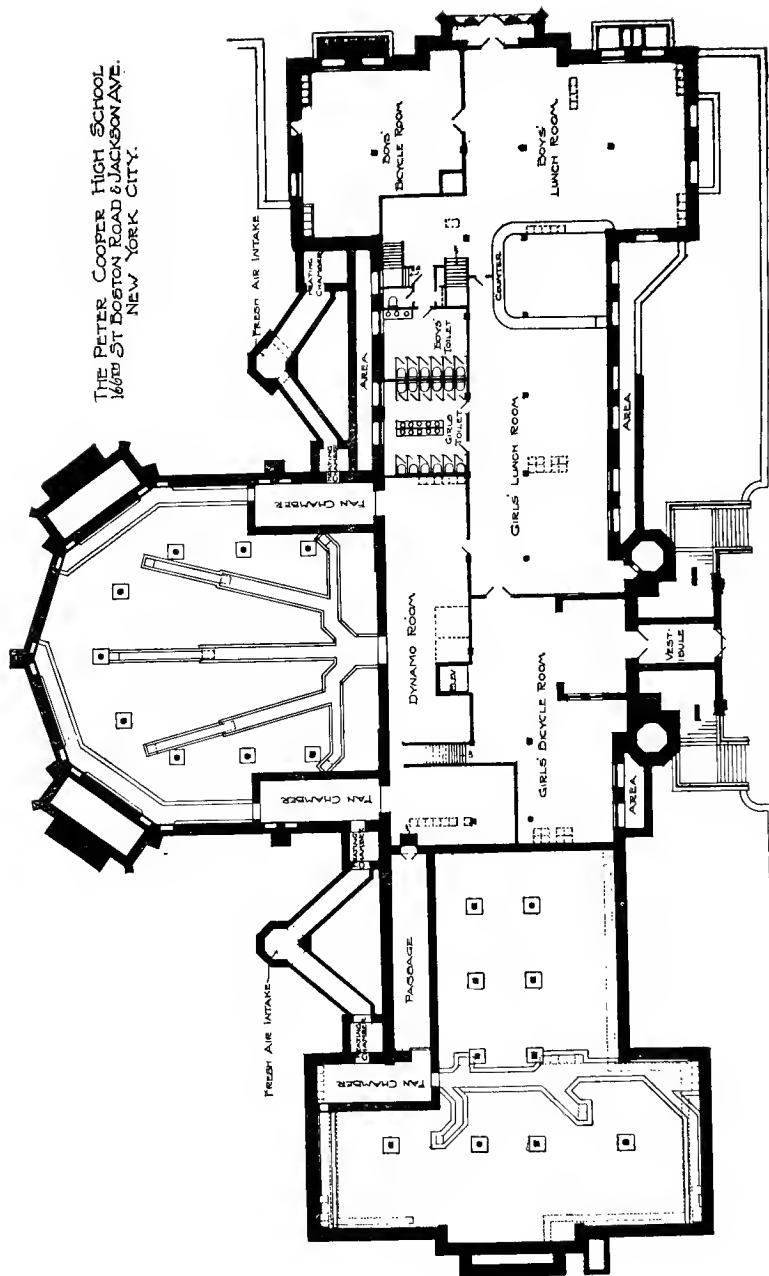
- George H. Deike, of Pittsburg, with J. S. Silliman and Company, Civil and Mining Engineers, Altoona, Pa.
- *Charles S. Freeman, of Pittsburg.
- *Harold G. Glenn, of State College.
- Edward N. Zern, of Lehigh, instructor in mining and mineralogy at the Pennsylvania State College, State College, Pa.

* A choice of positions offered, but none yet accepted.



The Peter Cooper High School.—New York City.

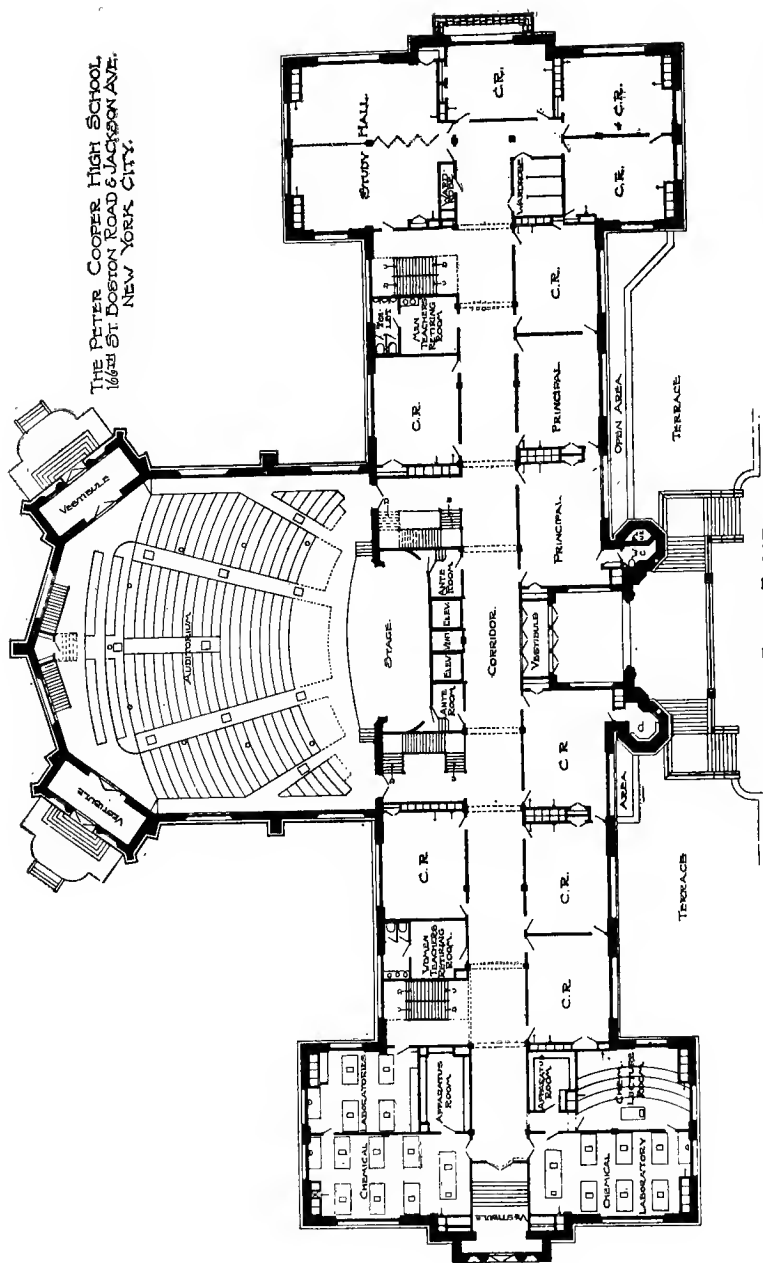
THE PETER COOPER HIGH SCHOOL
166TH ST BOSTON ROAD & JACKSON AVE.
NEW YORK CITY.



PLAN OF BASEMENT
SCALE: 1/8" = 1'-0"

GRJ SAVINER ARCHTCT
SUITE 601 1000 BROADWAY
NEW YORK CITY

The Peter Cooper High School.—New York City.



THE PETER COOPER HIGH SCHOOL,
166th ST DOSTON ROAD & JACKSON AVE.
NEW YORK CITY.

PLAN OF FIRST FLOOR.
SCALE 1/4" = 1'-0"

C. J. ENRIE ARCHT.
C. J. ENRIE ARCHT.
BANK AVE COR 5TH ST NYC

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The Peter Cooper High School.—New York City.

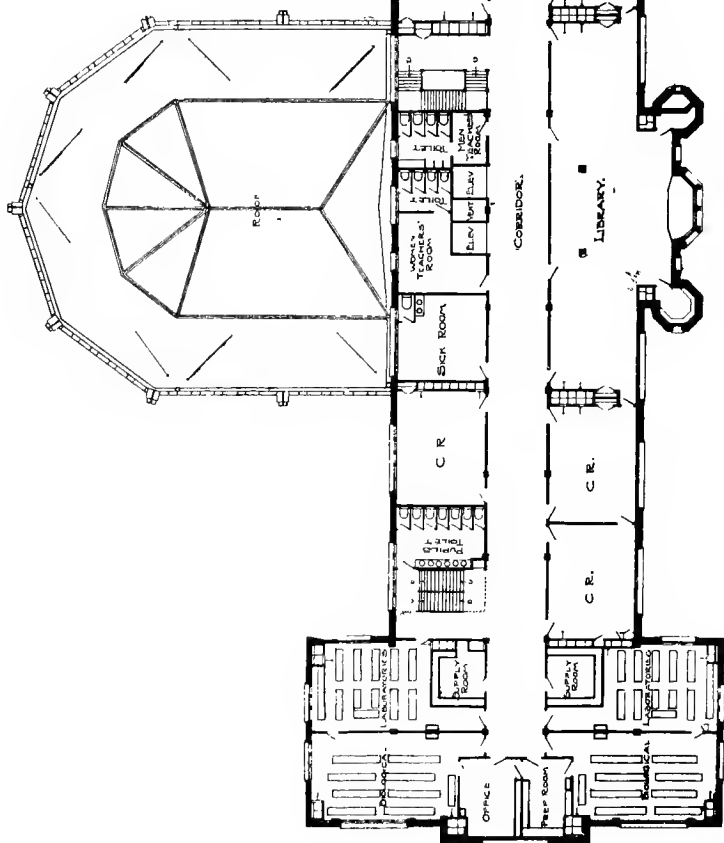
THE PETER COOPER HIGH SCHOOL
166TH ST BOSTON ROAD & JACKSON AVE.
NEW YORK CITY.

The floor plan illustrates the layout of The Peter Cooper High School. The central feature is the large, octagonal Auditorium with a tiered seating area and a stage. To the left of the Auditorium is the Gallery. To the right is the Study Hall. The main corridor runs horizontally through the center, connecting the Auditorium, Gallery, and Study Hall. The corridor is flanked by various rooms, including classrooms (CR), laboratories (PHYSICAL LABORATORIES), and a central lecture hall (GENERAL LECTURE HALL). The plan also shows restrooms (TOILET), a library (LIBRARY), and a gymnasium (GYMNASIUM). The building has a symmetrical design with a central entrance and a large auditorium.

PLAN OF SECOND FLOOR
SCALE: 1/4" = 1'-0"

The Peter Cooper High School.—New York City.

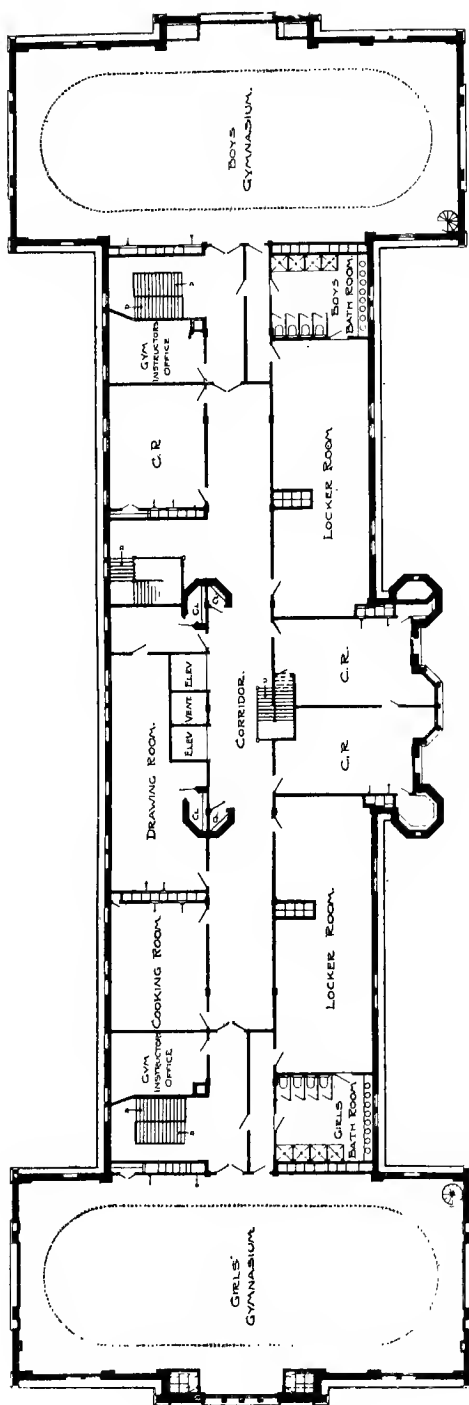
THE PETER COOPER HIGH SCHOOL
166TH ST BOSTON ROAD & JACKSON AVE
NEW YORK CITY



PLAN OF THIRD FLOOR.
SCALE: $\frac{1}{4}$ " = 1'-0".

The Peter Cooper High School.—New York City.

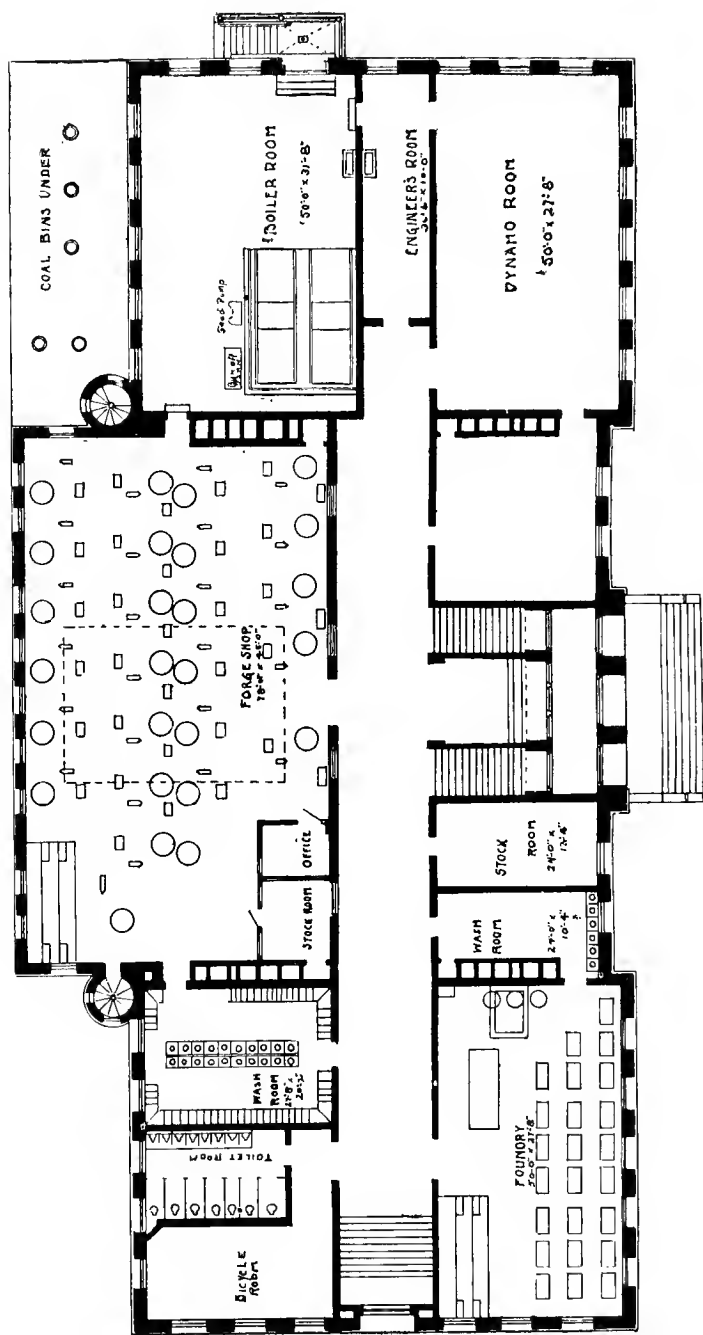
6
C.D. JENNYER ARCHITECT
DEPT. OF SCHOOL BUILDINGS
PARK AVE COR. 57th ST. N.Y.C.



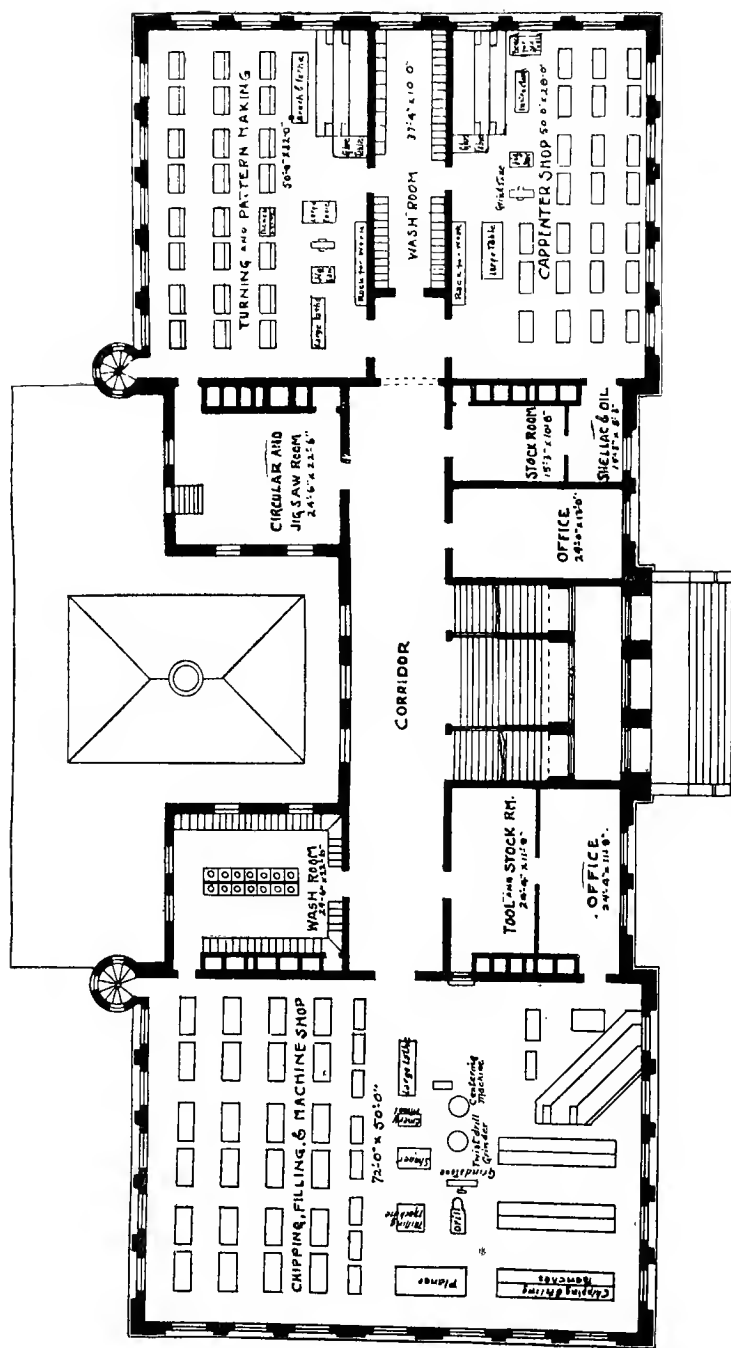
PLAN OF FIFTH FLOOR
SCALE 1/8" = 1'-0"

The Peter Cooper High School.—New York City.

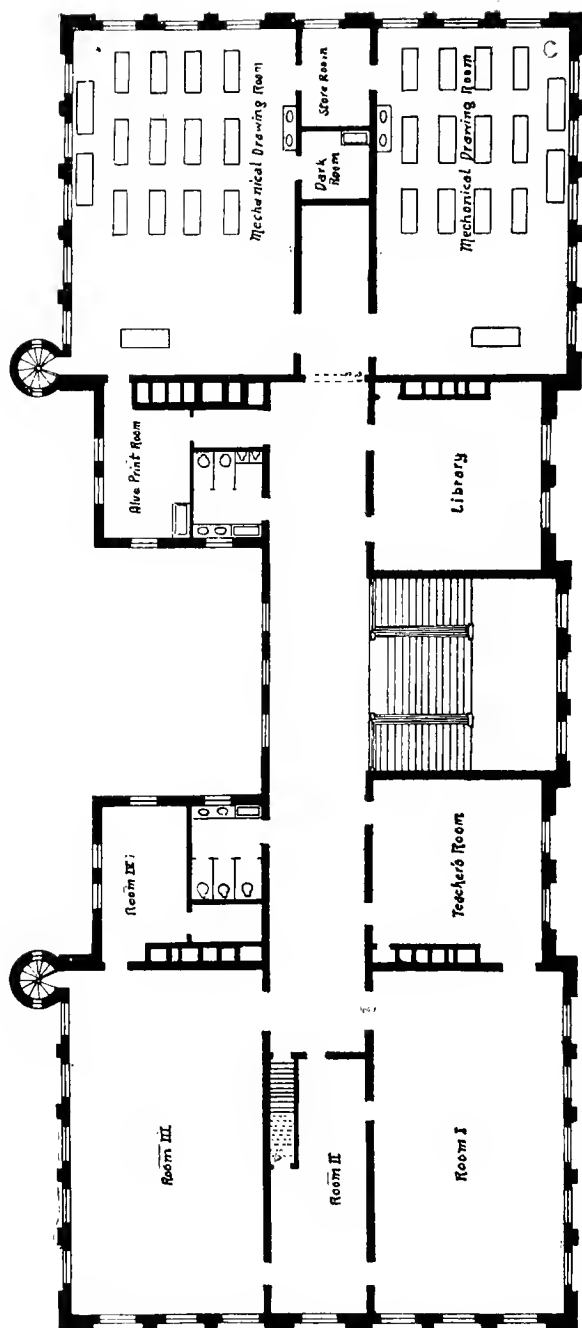
C. J. SANDER ARCHITECT
COURT OF SCHOOL BUILDINGS
PARK AND COR. 57th ST. N.Y.C.



Basement Plan.—Brookline Manual Training High School.



First Floor Plan.—Brookline Manual Training High School.



SECOND FLOOR
Brookline Manual Training High School.

LETTERS FROM INDUSTRIAL LEADERS.

LETTERS FROM INDUSTRIAL LEADERS.

EXTRACT of letter from Professor JOHN E. SWEET, Syracuse, New York.

"While I am not in a position to have my answers to your questions of much value, I have now for the past thirty years been interested in the training of young men. I use the word training instead of education intentionally, believing that the trained man is a useful man, while the educated man may be of use or of no use except to himself.

"It is now forty years since I lived in England, but what I can remember of the English lad of twelve or thirteen years of age and what I know of the American boy of say fourteen years of age, the English lad was trained, and well understood the subjects he studied, while the American boy of to-day has a crude idea of too many subjects. The English lad was disciplined; the American boy is hardly controllable.

"The thirteen or fourteen year old boy of this country has two or three years of high school before him, except in the rare opportunities offered by a few trade schools, which are the ones that are going to make the best farmers, mechanics, and commercial men.

"Wealthy men should send their sons to college, but in this country there is a large number of less able people who have themselves felt the lack of education, who ask themselves 'What shall I do with my boy?' and what they should do, in my opinion, is to ask the boy, 'What do you want to do?' That is, do more to learn the bent of the boy's mind. This the trade school does more than the technical school or college, because the trade schools are not popular, and neither parents or boys select the trade school except because the boy likes it. A very large percentage of the trade school boys succeed, while not much over half of the college graduates profit the world much.

"The two undesirable features about our school and college systems are the examinations and the diplomas. The examinations are held to determine the relative ability of the students, and it is absolutely unreliable. The diplomas inspire the students to cram for examinations rather than to get at the bottom of the subjects they are studying. The Trade School need not be hampered by these things.

"I found that of my students at Cornell University, those who did not graduate or aim to, proved in the end to soonest gain prominent positions, and also to hold them, and, in the main, keep ahead.

"The college, the technical school, and the trade school all have their places, and the Trade School in this country is growing more and more a necessity, and is almost entirely neglected.

"There needs to be from ten to a hundred workmen to every engineer, and yet we have hardly one trade school to a hundred engineering colleges.

"This does not answer your question directly, but my belief is this, that those young men who receive experience in practical work in connection with their studies and technical training will be more successful in conducting business, constructing work, and the management of men than the college man who takes up the practical work after the completion of a college course, or a course in the technical school where the practical work is only laboratory experiments."

EXTRACT of letter from C. W. WATSON, Esq., President of the Consolidation Coal Company, Baltimore.

"The policy of the companies I represent is not pronounced upon any of the points which you raise. On the industrial side we have three managers of mines, all efficient; one of whom, now middle aged, developed from an errand boy through practical experience supplemented by

a course at a school which imparts technical education by correspondence ; another, who is now elderly, received the training of a technical school of a generation ago ; the third, who is still young, received a thorough education from his boyhood, directed by his father, himself an experienced mine manager, to the development of technical and administrative ability both by early association with the mines, by training at home, and later at a good technical school. This latter kind of training applied to the right kind of material would, I think in the majority of cases, produce the best results.

"On the selling side, our representatives are mostly young men who, after obtaining a common school education, have entered business early and developed through experience. I doubt if such academic training as is provided in institutions above the high schools would be of much assistance in their pursuits. The training of the ordinary business college sometimes helps to fit young men for actual business, and perhaps the schools of commerce and finance that a few of the universities have recently established may be more effective in this respect, but they have not been long enough in existence to enable us to judge of their results.

"There is still abundant opportunity for the boy who leaves school at sixteen or seventeen years of age and enters business to rise, while the lad who comes out of college at twenty-two or twenty-three and enters business is undoubtedly handicapped, especially if he has taken the classical course. As I have said, however, it is different if he has taken a specific course definitely directed to fit him for a chosen career."

EXTRACT of letters from PAUL L. WOLFEL, Esq., Chief Engineer in the Engineering Department of the American Bridge Company, Philadelphia.

"For your information, I wish to say that the engineering department of this company employs at the present time about 650 engineers, draughtsmen, and clerks. We have established a practice that only in exceptional cases we give employment to experienced men, putting them over the heads of our own employees. We prefer to bring up our own force from the young high school and manual training school boys, or from college graduates. The high school and manual training school boys are employed by us under a regular apprenticeship agreement, copy of which please find attached, and the working of this system is fully described in a letter I have written to the president of this company under date of May 26, 1902, copy of which also please find attached.

"I find that it is entirely satisfactory to engage each year about one apprentice to every twenty or twenty-five men employed. In addition to this, every year we get in communication with the different colleges, who refer to us men that seem to be best adapted for the class of work we have to handle. It is, of course, only natural that the college men have a much better chance to work up to better positions, while the apprentice graduates very seldom develop into designers or engineers-in-charge, but mostly confine themselves to the preparation of shop drawings, frequently taking charge of the preparation of such drawings. We have had, however, a few exceptional cases where, through home study, apprentices developed themselves so that they have rendered us as good service as most college graduates we have. These, of course, are rare exceptions. As a whole the college graduate, however, has a great advantage over the boy that is employed from the high school or manual training school. The best results I find are obtained if a young man, after graduating from a high school or manual training school, spends one or two years in practical work or in a drawing work under the apprenticeship system, and then goes to college. Whenever we run across a case of this nature, we give the young man every encouragement possible, re-employing him during his vacation time under the same advances he would have had under his

apprenticeship agreement, and are always glad to re-employ him permanently with the company after he graduates from college. I am satisfied that the young man who follows this course has a very great advantage over the young man who goes to college direct from the high school or manual training school. The main reason for this is that when he takes up his studies he will naturally take them up with more earnestness as he has felt before that he was lacking in knowledge for his work, and further on, after he has graduated, he has already passed through the years where a certain practical experience must be gathered before the theories, which are taught in college, can be applied; he, therefore, much sooner, has a chance to apply his superior knowledge. This, I think, is of the more importance as I have found cases over and over again that by the time the young college graduate had sufficiently advanced in the practical end of the work to apply his knowledge he had forgotten the best part of the same. You understand, of course, that the above statements only refer to the engineering department of this company.

"In the operating department, I am satisfied that the men without the higher technical education have a comparatively better chance for promotion than in the engineering department."

"Apprentices are employed in the engineering department of the American Bridge Company under the four years' term, as per agreement attached. They must be graduates of the grammar schools, but boys with two years in the high school or manual training school are preferred. Before the agreement is signed, they are taken on three months' trial, which time, if the boy is retained by the company, is counted in as part of the first year. All men in charge are instructed to be extremely careful not to have boys sign the agreement unless they are reasonably sure, after the three months' trial, that the boy has the proper qualifications; if there is any doubt as to this matter, another three months' trial is given him, which is treated just the same as the first three months. If a boy is a graduate of the high school or manual training school, and if he proves, in the three months he is on trial, that he has derived the proper benefit from his schooling, the time of apprenticeship is reduced by one year, and the agreement made to read that way. These boys, in other words, serve their three months' trial in the first year term; they serve nine months of the second year term, and then wind up with the third and fourth years. The boys receive, free of charge, instructions in mathematics and mechanics in an evening class that extends over two years. In these classes they have to pass their monthly and semi-yearly examinations, and anybody who does not pass in the semi-yearly examination with an average above .70, has to go over the same course again. The boys who show up best in their classes are given preference in the work in the drawing-rooms. In each drawing-room it is understood that every year the most successful apprentice is rewarded by having his apprenticeship reduced six months, which six months, as a rule, are taken off in the second half of the third year. If this is decided on, he is so advised by letter, and a copy of this letter is filed with the original apprentice agreement in the auditor's office. This letter distinctly states that the reduction is made as a reward for his satisfactory services. I have found this a great stimulus for the boys. In the fourth year, or after the termination of their apprenticeship, we try to give the best of the boys some experience as inspector in the shop.

"When we tried to establish this system in the American Bridge Company, we were advised in a good many places, like Pittsburg, Brooklyn, &c., that it would be impossible to establish this system there, as the boys could get more profitable employment in other places. Experience, however, has proved that we get about twice as many applications as can be taken care of. I find that the longer the system works, the class of boys applying gets better and better, and can assure you that even the average boy in his fourth year does a great deal better work than the average man we can hire from outside at \$15 a week. It is the intention by-and-by to recruit our forces entirely from these boys—as is practically being done now at Pencoyd and Edge Moor, where the system has been working the

longest—with the exception of college graduates, whom we employ as students, at the fixed rate of \$12 per week for six months, after the expiration of which time they are rated in accordance with their ability.

“As an example of the number of apprentices that can be successfully handled in the drawing-room, I beg to inform you that at Pencoyd, out of 104 men, 23 are working under apprenticeship agreements, and in the eastern division drawing-room, out of 111 men, 19.”

EXTRACT of letter from R. VIALL, Esq., Superintendent of the Brown and Sharpe Manufacturing Co., Providence, R. I.

“We have looked the matter up somewhat, and find that in our drawing-room, in the different departments, we have thirty-seven men; out of that number there are only two regular technical men. There is one from the Pratt Institute, five from the manual training high school, and six from the school of design of our city. Those not included in the above had given some attention to drawing before coming here, to a greater or less extent.

“Young men from training schools such as we have described we take here for two years and a half, and while they are not regularly indentured, it is a kind of apprenticeship, as they come to a written agreement. So far they have kept this, and we have had no trouble about their leaving us.

“Our chief engineer, who attends to the designing of our buildings, looks after the power plant, heating, and everything that pertains to that class of work, is a technical man; he also spent two or three years in Cornell University, and then served three years in a shop where steam engines are made. We have had quite a number of technical boys here from time to time in our machine shops, but for one reason and another they have not remained very long; neither have they been of much value to us. Also we have had several college-bred men, and usually we have put them right into our gear-cutting department, where there is some mathematical work to be done, which gives them an opportunity for study, and also for getting a little practical work. They, however, have never remained with us any length of time, and therefore were of no permanent value to us.

“So far as our machine shops are concerned and the general business in the machinery line, our own ex-apprentices have the management. We have thirty-six in the works taking responsible positions, from that of head draftsman down. There are also a large number holding responsible positions outside of our works, some of them managing large concerns. We have in mind at this time at least forty-five of these ex-apprentices, and there are many more. The late Mr. Sharpe, of the firm of Brown and Sharpe Manufacturing Company, was an apprentice of Mr. Joseph Brown, senior member of the firm, and was taken into the business after he had served his time. So the apprenticeship system in this company is a fixed matter, and has been for between fifty and sixty years. If every manufacturer of machinery in these United States had pursued the apprentice system with the interest that Brown and Sharpe have there would be no dearth of first-class workmen in this country; but by most parties this has been neglected, or, what is as bad, they have pursued some shiftless system that was of no practical value to them, and so they have had to look elsewhere for their help.

“Enclosed we are sending you a copy of our terms of apprenticeship, and that of the Baldwin Locomotive Works, which latter we think is the best there is in this country for that class of work; but for our work, which is more uniform in character, we consider ours the best.

“So, reviewing the history of this company, you can see that there are plenty of openings for boys of character and ability, and a good future for them. Of the number mentioned in the management of this business, several of them were prepared for college, but instead of going there came here and learned a trade.”

EXTRACT of letter from A. L. ROHRER, Esq., Electrical Superintendent—Schenectady Works—of the General Electric Company, Schenectady, N. Y.

"The Schenectady Works employ perhaps as large, if not a larger, number of technical men than any other industrial works in the country, and, as we are doing business with almost all civilised countries of the world, we receive a large number of applications from young men who have completed a course in electrical engineering. The largest number of these young men are, of course, Americans, and come to us from the different technical schools in this country.

"We will not attempt to answer your questions in the order which you have put them, but instead will give a general idea as to how these men are employed.

"Our business being the manufacture of electrical apparatus, necessitates our employing a large corps of men whose duties are to test apparatus and see that it is free from defects, that it meets guarantees which have been made, that it will accomplish the work, and that it meets the expectations of the designing engineer. It goes without saying that men with technical education are preferred for this work, and we have at the present time 264 of these men in our testing department. In addition to these we have a few men who have received a partial training in the theory, but for financial or other reasons, were not able to continue in college, and left to go to work, and have had several years' practical experience with either electric lighting or electric railway companies. These men come to us then with some of the theory and considerable practical experience. We find that some of these are bright fellows, and are able to acquit themselves with credit. All men who are admitted to the testing department are required to be at least twenty-one years of age, and either a graduate of some technical school or have had such experience in machine shop, repair shop, or central station as would, in our opinion, enable them to do satisfactory work in that department, which means that boys who have had high school work or manual training school work only, are not admitted unless they have had years of practical experience. However, many of these boys secure positions in the different mechanical departments of our works, where they make very good workmen, and some of them become expert mechanics.

"The men who are admitted to our testing department are expected to remain there from twelve to eighteen months; at the end of this period they are eligible for positions in either our engineering or commercial departments, and some secure appointments through us with our best customers. A large percentage of the men in our important departments, and those in our branch offices have had the training which our testing department affords, and are, therefore, familiar with our apparatus.

You may be interested in knowing the different schools and colleges which are represented by the young men now in our testing department, and I give them as follows:—

College.	State.	No.
Clemson College, ...	North Carolina,	8
Purdue University, ...	Indiana, ...	10
Lehigh University, ...	Pennsylvania, ...	5
Columbia University, ...	New York, ...	11
Alabama Polytechnic Institute, ...	Alabama, ...	11
University of Nebraska, ...	Nebraska, ...	5
North Carolina Agricultural and Mechanical College, ...	North Carolina, ...	3
Massachusetts Institute of Technology, ...	Massachusetts, ...	9
Princeton University, ...	New Jersey, ...	2
Pennsylvania State College, ...	Pennsylvania, ...	10
Sheffield Scientific School (Yale), ...	Connecticut, ...	8
Union University, ...	New York, ...	3

College.	State.	No.
Worcester Polytechnic Institute, ...	Massachusetts, ...	7
University of Tennessee, ...	Tennessee, ...	1
Iowa State College, ...	Iowa, ...	4
University of Kansas, ...	Kansas, ...	3
Virginia Military Institute, ...	Virginia, ...	2
University of Vermont, ...	Vermont, ...	6
Kansas State University, ...	Kansas, ...	1
Ohio State University, ...	Ohio, ...	8
Tufts College, ...	Massachusetts, ...	4
Bliss Electrical School, ...	District of Columbia, ...	3
Virginia Polytechnic Institute, ...	Virginia, ...	4
University of Wisconsin, ...	Wisconsin, ...	8
Syracuse University, ...	New York, ...	1
Brown University, ...	Rhode Island, ...	2
Clarkson School of Technology, ...	New York, ...	1
Armour Institute of Technology, ...	Illinois, ...	3
Cornell University, ...	New York, ...	13
Pratt Institute, ...	New York, ...	9
Oklahoma Agriculture and Mechanical College, ...	Oklahoma, ...	2
University of Illinois, ...	Illinois, ...	3
University of California, ...	California, ...	4
Colgate University, ...	New York, ...	2
Georgia School of Technology, ...	Georgia, ...	2
Trinity College, ...	Connecticut, ...	1
New Hampshire State College, ...	New Hampshire, ...	1
Rose Polytechnic Institute, ...	Indiana, ...	4
University of Colorado, ...	Colorado, ...	1
Maryland Institute, ...	Maryland, ...	1
University of Georgia, ...	Georgia, ...	1
Harvard University, ...	Massachusetts, ...	4
University of Minnesota, ...	Minnesota, ...	3
Stevens Institute of Technology, ...	New Jersey, ...	2
Williams' College, ...	—	1
University of Virginia, ...	Virginia, ...	2
John Hopkins College, ...	Maryland, ...	1
Amherst College, ...	Massachusetts, ...	1
Michigan Agricultural College, ...	Michigan, ...	1
Case School of Applied Science, ...	Ohio, ...	1
University of Michigan, ...	Michigan, ...	4
University of Maine, ...	Maine, ...	7
Oregon Agriculture College, ...	Oregon, ...	1
Culver Military Institute, ...	—	1
Leland Stanford University, ...	California, ...	3
Tulane University, ...	Louisiana, ...	2
Wesleyan University, ...	Connecticut, ...	1
Foreigners, ...	—	41

We do not regard all of the above institutions as being on the same basis. There are some whose laboratory equipment is not up to the best course in electrical engineering, and I might say that the men who come from these institutions are men who have had, in addition to their college or school work, considerable experience, which would fit them fairly well for the work in our testing department.

You will note that those technical schools which make a speciality of mechanical and electrical engineering are well represented."

EXTRACT of letter from HENRY R. TOWNE, ESQ., President of the Yale and Towne Manufacturing Company, New York City.

"The Yale and Towne Manufacturing Co. employs usually about twenty-five hundred persons in its works at Stamford, Ct. Its products consist chiefly of locks of every kind, and of builders' hardware, but they include

also chain blocks and other hoisting appliances, and numerous specialities. The character of the business may be designated as "light manufacturing," but it embraces a very wide range of trades and processes. Metallurgy and chemistry are both important elements in the operations of the business, and good technical management in both is essential. The mechanical operations involved cover nearly every variety of machine tool and a large amount of automatic machinery, thus requiring a high grade of technical knowledge in metal-working. Engineering knowledge of a higher grade is required in connection with the department which produces hoisting machinery, and still more in connection with the large steam and electrical plant required for the operation of the works. This general statement will give you an idea as to the technical requirements of the business.

Basing my statements on my long experience in this business, I reply as follows to your several questions:—

(a.) On the industrial side of the business we consider it essential that the men responsible for the conduct of engineering matters should be graduates of a technical school, and our experience with men of this class has been satisfactory.

(b.) On the commercial or selling side of our business, we have also employed technical graduates, and we consider technical training as very valuable in this department. We find it difficult, however, to retain such men in this work except in positions commanding high salaries, because they usually prefer positions in the drawing offices or works, and these usually command higher compensation. The ability to effectively present and sell goods of any kind is to some extent a natural gift. A young man having this ability and desiring to utilise it in connection with a machine product, would always be benefited by devoting some time to a technical training in the sciences relating to the product which he expects to sell.

As a rule, however, in our business, the men connected with the sales department are not graduates of technical schools.

(c.) In my opinion a young man who desires employment in the industrial field, and who aims to attain a position of responsibility, will always have a better chance if he can have the benefit of a course in one of our technical schools, such as the Massachusetts Institute of Technology. If such a person prefers the commercial or selling side of the business, such a training is of course less essential, but in this case also he will be much benefited, and, other things being equal, will have an advantage over another who is without any technical training in the theory or science of his business.

(d.) For technical work, either in the shops, drawing office, or sales department, men who have taken a course in a technical school are distinctly preferable to those who have had only a high school education.

In our works we have for some years maintained a system of training for young men who desire to qualify for permanent positions in our business. For this purpose we have established two courses, one to train the students for commercial work, and the other to train them for positions in our works. Both courses are three years in length, and during this time the young men are paid at about the same rate as apprentices. During their course they are under the charge of a committee composed of several of the leading managers in the works, who follow each individual during his course, to see that he has the proper opportunities, and, guided by his department during the course, they modify it within certain limits, in order to aid in qualifying him for the kind of work for which he seems best adapted. Upon the completion of the course we are always glad to offer permanent employment to a young man who has made a good record. In a business which is as highly specialised as ours this plan has the great advantage of giving a young man who only has a general training, the one which will fit him for the special work he proposes to devote himself to permanently. Finally, I may state that in our works there is absolutely no limit to the opportunities for advancement, that we are always ready to promote those who merit it by ability and efficiency, and that many of our most important positions are filled by men who have grown up in the business."

EXTRACT of letter from WM. H. NICHOLS, Esq., President of
the General Chemical Company, New York.

"I have requested several gentlemen connected with this company to write me their individual views in regard to the matters contained in your letter, in order to give you as many points of view as possible. I will briefly state my own views in answering your questions.

"In our manufacturing department we use a large proportion of technically-trained men; in fact it would not be likely that any man without technical training (such as he would obtain at Cornell or Boston Institute of Technology) could reach a very high position in that department.

"In our sales department we feel the need of technically-trained men, but unfortunately find that, as a rule, they have not got the necessary business training to make them good salesmen; hence a large proportion of men engaged in selling are not college men. We have, however, several college graduates among our salesmen, who have reached high positions. (This answers briefly your questions "a" and "b.")

"To question 'c,' I would reply that in my opinion the best preparation for either the technical or business side of the work is college training—either scientific and technical, or the ordinary arts course. From my observation there can be no question that the man so equipped is in a better position (everything else being equal) to make rapid advances in usefulness. There are notable exceptions to this in our own company, but these gentlemen have become useful by force of native ability, which, I cannot help but think, would have been still more useful if it had had the benefit of college training.

"In answer to your question 'd,' I would say that the above practically covers my views, which I would sum up by stating that I consider (everything else being equal) college men preferable to boys who have had a high school education; the latter preferable to those who have been trained in manual schools, and the latter still preferable to those who have had an ordinary common school education. As a concrete example, I would state that the president of this company is a graduate of New York University; the first vice-president, of Dartmouth College; the second and third vice-presidents, of Yale University; the secretary, treasurer, and chairman of the executive committee are not college men; the chief engineer, Mr. Herreshoff, is a Brown University man; Mr. Lancaster Morgan, manager of the manufacturing department, is a Yale man; his assistant, Mr. C. W. Nichols, is a Cornell man; Mr. C. F. Wright is a graduate of Dublin University; Mr. Sholes is not a college man."

EXTRACT of letter from T. B. F. HERRESHOFF, Esq., Consulting
Engineer and Manager of Construction Department of
the General Chemical Company, New York.

"I am, as you know, greatly in favour of technical education for men who wish to make a marked success when connected with various industrial institutions. In the case of the General Chemical Company, our manufacturing department is fully convinced that it is absolutely necessary to employ in the factories a certain number of men who have received a college education, especially in the scientific studies as applied to mechanical engineering and chemistry. This also applies to our office staff, including the manufacturing, purchasing, and sales departments.

"What applies to our own conditions would be applicable also to manufacturing industries in the whole country. The manufactured articles produced in the United States are valued at \$13,000,000,000. The products of our agriculture aggregate \$4,000,000,000. You will see from this the necessity for higher scientific and technical education such as are found in our American colleges. It is also of vast importance that our public schools, including the grammar and high schools, should turn out

men who are better versed in technical matters. I believe the rapid advance of the manufacturing industries in Germany is due largely to their strict attention to the higher scientific and technical education, and also to the fact that technical education in the ordinary schools receives great consideration in that country."

EXTRACT of letter from L. MORGAN, ESQ., Manager of the
General Chemical Company, New York.

"As to whether this company employs technically-trained men:—

"We do. On our technical staff we employ graduates of a number of the scientific or technical schools, viz:—

School of Mines, Columbia University.
Boston Institute of Technology.
Cornell University.
University of Vermont.
Sheffield Scientific School, Yale University.
University of Pennsylvania; and others.

"(a.) Graduates of technical schools in our employ are engaged mainly in the productive departments.

"(b.) In the business or selling departments of this company the proportion of technical men is extremely small.

"(c.) Speaking generally, it has been our endeavour to secure for the technical staff graduates of the best technical schools, who have received a thorough chemical training, combined, if possible, with a short course in engineering.

"(d.) Generally speaking, university graduates are apparently preferable in all departments to men who have had only a high school education, the severe mental training incident to a properly followed university course giving the graduate a capacity for rapid business development often not possessed by the boy from school. It has not been our experience that the university graduate is handicapped by entering business life later than the high school graduate, for the reason that the years of preparation spent at college enable the graduate, if he is a man of ability, to broaden and develop more rapidly and with less clearly-defined limitations than the man without the advanced education."

EXTRACT of letter from C. E. SHOLES, ESQ., Assistant Manager
of the General Chemical Company, New York.

"The term 'college-bred' is misleading. I esteem that a graduate of a *university* or a *technical school* would be usually required by the manufacturing and laboratory departments. In answer to question 'a,' I would esteem that such graduates would be preferable and accomplish the greatest progress in those departments.

"As to inquiry 'b,' I would consider that the question is entirely one of individual ability. The university graduate has an advantage in coming to us generally well-informed, but a majority of such graduates find it difficult to appreciate commercial values, and lack ambition along those lines.

"In regard to question 'c,' I consider that a man equipped with a fair knowledge of the commercial uses of chemicals, a reasonable knowledge of accounting matters, and stenography, is best equipped for progress.

"Question 'd' is wholly a matter of individual ability, but as a rule the boy with the high school education has more ambition than the one who has had four years of *college* life, with its insignificant study. Of course, I except from this the *university* or *technical school* graduate, who rarely applies to us for a small office position."

EXTRACT of letter from C. E. WRIGHT, Esq., General Auditor
of the General Chemical Company, New York.

"(a.) Yes; the chemical industry requires as a *sine qua non* in its productive departments, men of the highest technical and collegiate education.

"(b.) Partially so. The 'business of selling,' while necessitating in trade with chemicals a higher technical equipment than in probably any other department of commerce, requires in particular men of address, and with a practical knowledge of men and affairs not in any way obtainable in a technical school. Some chemical education is necessary for the salesman to effectively canvass, but experience has shown that the technical knowledge, be it great or small, must, in this branch of the business, always be subservient to the practical results.

"(c.) A technical education for the producing departments; practical trading and business instincts and ability to cope with other men for the business departments.

"(d.) College men, or those with a definite training, are always primarily better equipped for any business or dealing with the world than those who have received a less mature education. But the practical individual of great mental acumen will always outstrip his duller companions, collegiate training by no means making the man, but merely adding to his resources. Given youths of equal mental powers and ambitions, and unquestionably those of scholarly attainments will outstrip the others in the battle of commerce.

"It may be added, however, that no matter how great or technical the training or education in any line, a man who has not the capabilities for selling can never be made a salesman, any more than can one of small brain calibre, however much he studies, ever be made a chemist; for in this branch of life, as in any other, *poeta nascitur, non fit.*"

EXTRACT of letter from FRANCIS M. BACON, Esq., of Bacon &
Co., New York.

"I regret that I find myself hardly able to give you the information which I think you desire, from the fact that my business does not require the services of the technically educated.

"It is managed by members of the firm who have the necessary experience, while the detail is done by boys and young men, who are employed without previous experience.

"The salesmen are usually selected from those young men who have been most faithful and intelligent employees for some years, in that way acquiring the knowledge of the business which enables them to dispose of merchandise.

"From my own experience, the best preparation for office or merchandise is to commence as an under clerk, and by application and intelligence, acquire the knowledge which would be of the greatest use to the employer.

"The difficulty with a college graduate is, that at the age of twenty-one or twenty-two, he is obliged to start with lads of sixteen or seventeen, though if he is a man of intelligence and ability, would most likely, after a couple of years of experience, be entitled to a much better position than his companion who started at the age of sixteen or seventeen.

"There is always room for a boy of ability and character with a common school education, and an opportunity in time to rise from the lowest to the best position in a firm.

"The writer, who is now the senior partner in our firm, having survived his employers and partner, started in this way at the age of seventeen."

EXTRACT of letter from HENRY D. MACDONA, Attorney and Counsellor-at-Law to the Metropolitan Street Railway Company, New York.

"First:—The great majority of the employees in the street railway service belong to what may be properly called 'non-technical' class. Technical men are engaged in the power houses, where the current for propelling, lighting, and heating the cars is developed. In all other branches of the business, the only school of training is the business itself. A great majority of the operating force, numbering about 14,000 men, is recruited directly from the population by the company itself. These men are first examined as to their physical qualifications in the work of operating moving vehicles, and if found up to the mental and physical standards set by the company, they are put into a training school, and there instructed as to the construction and arrangement of the mechanism they are ultimately to be put in charge of. This usually takes about two weeks. They are then taken and put upon the cars in charge of the older hands, and gradually familiarised with the control of the vehicles. From this class, thus recruited, the heads of departments, superintendents, and what-not else are in turn recruited.

"In the repair shops the highest class of skilled labour is at work; men who have had large experience in car manufacturing concerns. Very few of these have had preliminary technical school training. They have been developed from shop apprentices."

EXTRACT of letter from ALFRED TIXITT, Esq., Vice-President of the Manhattan Railway Company, New York.

"I set forth below my views on the relations of technical instruction and industrial commerce in the United States as illustrated in the Elevated Railway System, in the boroughs of Manhattan and the Bronx, this city.

"To enable you to more clearly understand the application of these views, I have divided the employees of our system into three classes, as follows:—

"(1.) Civil engineers, electrical engineers, mechanical engineers, and their respective assistants.

"(2.) All other employees in the following departments of the service:—

"(a.) Employees engaged in the work of maintenance of way, buildings, bridges, and structures.

"(b.) Employees engaged in the work of maintenance of equipment.

"(c.) Employees in the transportation department.

"(d.) Employees engaged in the work of generating and distributing power supply.

"(3.) Office employees.

"Technical knowledge is required to produce things, and experience to maintain and operate them; the adjustment of these two elements is the great problem in railroad work.

"Of the employees classed under Sub-division 1, one-half may be said to be technically trained; the other half consists of draughtsmen and men who have acquired skill in limited lines. For this class, college graduates are preferred, because, considering their absolute value and desirability, they are the most economical.

"With respect to Sub-division 2, we prefer technically-trained men for positions which direct the labour and activities of others, but in most positions necessary to the maintenance and operation of a railroad, permanency in position is desirable, and as it often happens that technically-trained men will not take the necessary initial subordinate position, nor can they be retained sufficiently long in such a capacity to secure the necessary experience required to render them proficient in the highest degree, it follows that a comparatively small portion of this class are men of technical training.

"I would here observe that there are numerous cases where men have achieved distinction who have not had the advantages of the technically trained, but who, however, have applied themselves and acquired a technical knowledge by laborious study at an age when it becomes a more difficult proposition than that which faces the student. Moreover, men will rise in position until they reach the limit of their powers, when they become practically fixtures, and it stands to reason that the men with the technical training, all things else being equal, will rise the highest.

"With respect to Sub-division 3, it appears to me that the college-bred men are at a disadvantage for the reason that, as they must be about twenty-three years of age before they enter upon the duties so required of them, they suffer considerably in comparison with the boy who left school at the age of sixteen or seventeen, and who has thus secured, by six or seven years of office experience, knowledge which proves of the greatest value to him. Moreover, the college-bred man, by force of circumstances, is denied the opportunity afforded by the modest beginning which so frequently leads to business success.

"There is considerable room for the boy of ability and character who, though minus the technical or college training, begins his business career about the age of seventeen upon a foundation of high-school graduation, and supplements it with an exhibition of earnestness, pluck, and careful attention to the interests intrusted to his charge."

EXTRACT of letter from JOHN CARSTENSEN, ESQ., Fourth Vice-President of the New York Central and Hudson River R. R. Co., New York.

"The New York Central and Hudson River Railroad Company (as well as the other large railroad companies of this country) frequently employs men who have had technical training. For example, under your caption 'a,' instances would be found in the laboratories connected with our shops where rails and other materials are tested, in our engineering department, and in the higher positions of our mechanical department.

"Under your caption 'b,' I would state that this company employs many men who have graduated from the various colleges and technical institutes of the country, although without exhaustive research it is impossible to tell the proportion these bear to the whole.

"So far as your caption 'c' is concerned, I would state that the men in responsible positions in our operating department have frequently worked their way up from the ranks, it being a branch of railroading calling for practical experience. So far as the office work is concerned, and also the traffic and engineering departments, the percentage of college men employed is usually greater. I do not intend to convey the idea that there are no college men holding responsible positions in the operating departments of our railroads, as this would not be true.

"As to caption 'd'—"Are college men preferable to boys who have had a high school education?"—I would answer that this depends largely upon the boys themselves. It has come under my observation that in some instances college men have not been fitted for the railroad work they have undertaken, where similar positions have been acceptably filled by boys who have not had the same education. Where technical knowledge is required, and other things being equal, the college man would certainly be preferable.

"You call attention to the fact that as a rule the college-bred man is twenty-two or twenty-three years of age before he is ready to enter upon office work, whereas the school graduate may start at sixteen or seventeen. In some instances this might work to the detriment of the college man, but if the latter is ambitious and diligent, it should not be a great handicap. I am most decidedly of the opinion that a 'boy of ability and character,' who has not had the advantage of a college education, may make his mark in the business world."

EXTRACT of letter from L. F. LOREE, Esq., President of the
Baltimore and Ohio Railroad Company, Baltimore.

"While the Baltimore and Ohio employs some fifty odd thousand men, from the nature of the service, the proportion of technically-trained men is comparatively small, and, until recently, men so trained were seldom employed in other than the technical branches of the work. Naturally, throughout the service there were a great many college-trained men, but as there had been no systematic method in effect for their employment, we are unable to give any statistics in relation to them. More recently, I have sought to have secured for all branches of the service a greater proportion of graduates from technical schools and universities; and, while this system has not been pursued for a sufficient length of time to demonstrate its effectiveness, I feel that it cannot fail to improve the standard and efficiency of our force.

"Answering your queries *seriatim* :—

"(a.) In our maintenance of way department, the officers of which are necessarily all engineers, there have been employed since January 1, 1903, fifty-nine graduates from technical schools and universities, of whom forty-nine have been retained in the service. These young men are assigned mostly to technical work, and, under the supervision of the officers, are given such practical training as opportunity affords, with the view of fitting them for official promotion. In addition, for the past two summers, we have employed a number of under-graduates, giving them the opportunity during their summer vacations to gain some practical experience. During the past summer we had twenty-eight of these under-graduates, all of them returning to their schools at the end of the season.

"In the transportation department, we began this year to employ college graduates in clerical positions in our yards and in the offices of our superintendents. Of these, out of seventeen employed, eight are still in the service, the others accepting positions elsewhere of higher remuneration. While it is desirable that the various heads of the transportation department should be technically-trained men, this is not considered absolutely essential, the technically-trained men reaching the higher positions in this department being drawn largely from the maintenance of way and mechanical departments. It has been our desire, however, to get a larger proportion of men of higher education into this branch of the service, and with this in view we have endeavoured to interest college graduates in this line of work; but, as evidenced by the fact above stated that out of seventeen employed this year only eight remained, the nature of the work and the low compensation possible in these positions render it difficult to secure and retain college men as beginners in this department.

"In the mechanical department, embracing the electrical department, it has for a number of years been the practice to afford an opportunity to young men to secure the technical training required therein. This has been accomplished through a system of apprenticeships in our shops, where young men are employed under the rules and regulations set forth in the enclosed printed circular. Of such apprentices there are at present in the employ of the company :—

Of the 1st class,	.	.	.	.	.	531
" 2nd "	.	.	.	.	.	4
" 3rd "	.	.	.	.	.	24
Total,	.	.	.	.	.	559

or about 7 per cent. of the total number of employees in this department.

"The 1st and 2nd classes, as you will note, simply require a common or high school education, and, excepting instances of unusual ability, rarely rise above the grade of the trained artisan. The third class, however, or those who, previous to entering the service, have had training at a college or technological institution, are given special opportunity to fit themselves for promotion to the higher positions in the mechanical department.

"(b.) On the 'commercial, or business or selling side,' of the railroad, in which we here include the traffic, accounting, and general office departments, comparatively few of the men are college graduates. The large proportion have had high school educations, and a number have had a year's training or more in what are here termed 'business colleges,' where they are taught rudimentary business laws and usages, commercial accounting, typewriting, stenography, &c. With this degree of education they are enabled to enter the service at an early age, while many enter as mere youths, with only a common school education, and receive their business training entirely in the offices.

"(c.) Eliminating the mere labourer, a common school education is essential, and a man's chances in all branches of the service improve according to the extent of his education. A good elementary education will fit a man for positions in all branches, excepting those in which purely technical knowledge is required, such as in the engineering and mechanical departments, as described above. In all technical departments of the railroad, it is very desirable to have men trained in a college or university.

"(d.) While opinions differ greatly as to the especial advantages of a college education in general railroad work, and while it is true, as you suggest, that the college-bred man, entering the service at twenty-two or twenty-three years of age, does not at that time appear to advantage compared with the lad who left school and entered at sixteen or seventeen, and in the meantime has become proficient in certain lines of work in his department, I think that when the college man has mastered the ordinary business practice, his superior intellectual training will soon tell in a readier grasp, broader view, and greater general capacity, and he will rapidly outstrip the other who started earlier but with a limited mental equipment.

"Answering your inquiry as to whether there is still room at the top for a boy of ability and character who has not had the advantages of a technical or college education: broadly speaking, there is still this chance, but with the continually increasing percentage of technically-trained and college-bred men entering the ranks, the contest for him becomes all the more difficult, and to attain to a high position he must be a man of exceptional mental qualities and perseverance."

EXTRACT of letter from THOS. RODD, Esq., Chief Engineer to the Pennsylvania Lines—West of Pittsburg—Pittsburg, Pa.

"I have your favour of the 7th inst., relating to our employes who have technical education. We have 121 men on our monthly pay-rolls, fifty-two of whom have technical education, nearly all being graduates of such colleges as you refer to. All applicants for positions in this department have to fill in a blank.

"The technical school or college graduates are usually about twenty-two or twenty-three years of age. We prefer college graduates, but there is as much of an opportunity for a boy to rise to the top as there ever was.

"The men seem somewhat better trained than they were formerly, but all technical work seems to be on a higher plane than at the time you refer to, a generation ago."

EXTRACT of letter from W. W. ATTERBURY, Esq., Pennsylvania Railroad Company, Philadelphia.

"The early history of the Pennsylvania Railroad bears evidence of the necessity for the use of men of engineering ability as executive officers. Civil engineers, who had worked on the preliminary surveys, and later on constructions, naturally, through knowledge of the property and familiarity with the conditions, were chosen as operating officers. As years passed, men were introduced in subordinate positions who had received

the benefit of technical training or had acquired it through study and experience. A regular line of advancement was open to them to become superintendents as opportunity or the necessity arose. These men were also used as executive officers in charge of our mechanical or motive power departments, the mechanical engineer, in contradistinction to the civil engineer, being of comparatively recent development. During the early 'eighties' the situation was such that a civil engineer was at the head of the transportation, maintenance of way, and motive power departments. About this time our technical schools were turning out well-developed mechanical engineers, whose preparation, although not as complete as that of the civil engineer, was sufficiently good to warrant the class distinction; and the motive power department began to introduce in the shops technically-trained men to develop in the same manner as had existed in the maintenance-of-way department for some years.

"The situation in both departments to-day is that we have a very large number of technically-trained men in subordinate positions who are working for advancement. The same opportunities for advancement in either department are open to all of our employees; and young men who show special aptitude, although not technically-trained, are advanced as their work warrants.

"The number of technically-trained men in the lower ranks of our organisation is, relatively to the total number of employees, startlingly small. Notwithstanding this fact, the number of men who are and make themselves available for promotion, and who have previously not had the benefit of a technical education, is so insignificant that it is decidedly the exception to find them. It is possible that our system of training technically-educated young men may have a tendency to lead us to overlook men who have not had such an education, but it is our constant endeavour to stimulate the desire of boys of ability and character to rise from the ranks. I believe it is a fact, and the history of the Pennsylvania Railroad well supports it, that a young man with a technical education has a great advantage over a man without a technical education, notwithstanding the fact that he may be handicapped by measure of his years.

"The subject is a broad one and, unfortunately when discussed, generally carries with it personal prejudice. It is possible, therefore, that my own statement might be contradicted, or at least modified, if made by one of our officers not college bred. The foregoing, therefore, should only be considered as my personal opinion."

EXTRACT of letter from H. N. WALLACE, ESQ., Chief Engineer
to the Illinois Central Railroad Company, Chicago.

"I can say that we have approximately 200 men in our engineering department who are either graduates of a technical institute or have had some training in that line, and in a few cases have had the benefit of a course in the correspondence school.

"We adopted the policy some years ago to employ in our engineering department only educated men, and have, as a rule, followed that policy to the present time. We employ men for our minor positions in engineering, and promote entirely from their ranks to the higher positions, in this way educating the men in our own methods, which, of course, always brings better results.

"We recognise the fact that there is a large proportion of young men who may not be financially able to go to college, and who have the ability and character to make excellent engineers, and to such men we make the proposition that if they will enter the course offered by the various correspondence schools, which you know is very inexpensive, that we will give them a position in the engineering department which will pay \$1.25 per day, and give them their own time to perfect themselves in their education. If the young man is of the right stuff, he can, as a rule, I believe, develop into a stronger man, and possibly more quickly than the man who

takes a purely technical education and graduates at the age of twenty-three or twenty-four years, for the reason that the first man sees the application of his technical education from the very start, and that therefore he will, by seeing the relation between the theory and practice, get to be a much stronger man."

EXTRACT of letter from L. S. THORNE, Esq., Vice-President and General Manager of the Texas and Pacific Railway Company, Dallas, Texas.

"I regret that we are not in a position to furnish you with the data requested. We have no established rules under which technically-trained men are admitted to the service of the company. In our shops and maintenance-of-way department, common school education is all that is required of apprentices. When increasing our forces in the several departments where skilled labour is required, applicants are required to pass an examination, covering the special service for which they are employed, the same as apprentices are required to pass an examination before being promoted to the higher grades of service. On our line, nearly every official has worked his way up from the ranks, entering the service when quite young men, and working their way up step by step. But very few of our employees are college graduates. We believe in all cases that the college education is desirable, and that every young man who can have the benefit of such advantages is better fitted for a business life; at the same time, very much depends upon the person. Some of the brightest and best men in our service are boys who came to us as messengers, and have secured their education while working their way along from one department to another, having practical experience to assist and help them; and, as suggested in your letter, these young men are bright and active business men, with considerable experience, by the time the college-bred man is through college and ready to take up work. Our advice in all cases to young men, where they can stand the expense of a college education, is to secure it."

EXTRACT of letter from R. C. CLOWRY, Esq., President of the Western Union Telegraph Company, New York.

"The Western Union Telegraph Company employs, directly and indirectly, about forty thousand persons—men, women, and boys. The service comprises the executive officers, *i.e.*, president, who is also general manager; vice-presidents and secretary; also an auditor; a treasurer; an assistant general manager; a superintendent of tariff or rate bureau; a superintendent of commercial news and quotation service; a general superintendent of construction; district superintendents of construction; general foremen; line inspectors, and expert men for construction and reconstruction work; electrical engineers and their assistants; and divisional general superintendents, who have charge of all classes of business in their divisions, under whom are district superintendents, assistant superintendents, inspectors, office managers, operators, cashiers, book-keepers, solicitors, clerks, messengers, &c.

"I know of no college-trained men in our service, although we make no discrimination against any class. Very nearly all of our employees entered our service while quite young, and have grown up and been advanced to higher positions in the business, and, with the exception of possibly some of the inspectors and line repairers, they all have a fair common school education. I think that even the line inspectors, and nearly all of the men in the construction gangs, are well educated for the positions they hold.

"We have a great many applications from college graduates, but as they have no practical knowledge of the business, they could only be used as clerks or book-keepers, and even these positions are all filled with persons who entered the service early in life."

FROM THE ASSISTANT GENERAL MANAGER OF THE SOLVAY
PROCESS COMPANY, SYRACUSE, NEW YORK.

"The Solvay Process Company was organized for the purpose of manufacturing soda products, principally the monocarbonate, bicarbonate, and caustic, known commercially in this country as soda ash, baking soda, and caustic soda. Associated with this Company we have the Semet-Solvay Company, producers of retort oven coke. The products and by-products of these companies require, all told, some 5,000 working men; of these necessarily a goodly number are technically trained men. They come from Harvard, Yale, Brown, Cornell, and other universities; from Troy Polytechnic, Columbia School of Mines, Massachusetts Institute of Technology, and similar institutions.

A partial list of the gentlemen who are responsible for the technical affairs of these companies will give you the best idea possible as to the value the companies place upon technical training:—

	Institution.
Mr. F. R. Hazard, President, ...	Brown.
„ W. B. Cogswell, Vice-President and Founder, ...	Troy Polytechnic.
„ R. G. Hazard, Vice-President, T.S.P. Co., and President, Semet-Solvay Co., ...	Brown.
„ E. N. Trump, General Manager and Chief En- gineer, T.S.P. Co., and Vice-President S. S. Co., ...	Cornell.
„ J. D. Pennock, Chief Chemist, ...	Harvard.
„ W. H. Blauvelt, General Manager and Engineer of Semet-Solvay Co., ...	Lafayette.
„ A. H. Green, Jr., Manager Detroit Department, T.S.P. Co., ...	Cornell.

Now, returning to your communication, and taking up the questions in the order in which they are given we have:—

(a.) "On the industrial or productive side," technically-trained men, with very few exceptions, are employed as department heads, and as assistants and sub-assistants to the same. Beneath them chief of foremen, general foremen, and sub-foremen, are men who have displayed special fitness and who have received special training in the various branches of the work, and to whom is entrusted the immediate supervision of the workmen.

This company, from its foundation to the present, has at all times generously encouraged the ambition of its youthful employees, to the extent of providing the assistance necessary to obtain a college or technical education (such as you doubtless have in mind) to those displaying the qualifications which have commended them to the attention of its officers. Such young men, after availing themselves of the opportunities afforded, and having returned to the company's employ after graduation, have with no exception, so far as the writer is aware, proven excellent men. You may not readily understand why this should be so, unless your attention is called to the peculiar benefits which some of us believe come to a college or technically trained man who has had more or less practical training between his graduation from our highest public school (known as the high school) and his entrance into college.

(b.) "On the commercial, or business, or selling side, of the operations of your firm; and if so, what proportion do these bear to the whole number of your employees?"—Dividing this general question into two heads, commercial or business (1), and selling (2), we have—

(1.) With the exception of the president of the company, in whom, fortunately, are combined the technical and the commercial, together with the assistant to the president, we have no college or technically trained men, their training having been purely commercial, they also having, in many cases, had an intimate acquaintance with practical affairs. With reference to recruits, excepting in special cases, training in these branches may be said to begin with the youth in attendance at the office door, who, if conduct warrants, is advanced as opportunity offers, and trained in the methods of his superiors, step by step.

(2.) The selling of the company's products is accomplished through a commercial agency.

(c.) "Would you be good enough to add what, in your opinion, is the best form of preparation for the industrial, and for the business side of your work?"

We have answered this question in part under questions (a) and (b), but would add that in the writer's opinion, based upon a training wholly practical, *i.e.*, in passing from early boyhood to the present time through factory, evening schools, including drawing schools workshops (joinery and machine), civil engineering field and office, chemical laboratory and manufactory, the combination of practical training with the too frequently termed theoretical or college training, is the best form of preparation for the industrial and the business sides of our work; all of which seems to be confirmed by the American training having produced so many men happily combining the industrial and business sides. You suggest, farther on in your letter, that such a training would bring young men to the age of "twenty-two or twenty-three years before they are ready to enter the works or the office"; but we think such young men are not so seriously handicapped as would at first appear, because their training has made them sharply alive to their surroundings, and they quickly overtake the young man from the public school.

(d.) "Are college men preferable to boys who have had a high school education?"

The answer to this in part is also included in what has been said above, that they are preferred; but, as said above, the high school boy is given a place and special opportunity, and, in fact, warm encouragement to look forward to a college training as the stepping-stone to a higher position than he could otherwise hope to obtain, excepting under extraordinary and favourable circumstances.

You also ask, "Whether there is still considerable room for the boy of ability and character who has not attended a technical institution or college, to rise from the ranks to the top of the firm." An instant "Yes!" is the only answer to this, else thousands must cease to hope, and therefore to work as one should for employer and self. In this country every boy calls to mind the words of Daniel Webster, to the effect that "there is always room at the top," and he strives to "get there."

In further to answer to question (c.) the writer's personal belief is exemplified in the course he is pursuing with his sons, two of whom are students in the Massachusetts Institute of Technology. Their younger brother is receiving machine shop training in anticipation of a later college course. The eldest son, after preparing for and passing the entrance examinations of the institute, spent one year in France and one year in Germany, devoting one-half day to the study of the country's language and the other to draughting and engineering in France, and to chemistry and manufacture in Germany, he having also had at least six months' previous training in machine shop work; all with the expectation of building as broad a foundation as possible upon which to rest his future technical training. The results of such a course are awaited with deepest interest. The second son has received a similar practical (shop) training as his brothers, but preferred immediate entrance into college, to be followed by such future special training as circumstances may dictate before entering into actual work.

Such a course you will concede will bring these young men to twenty-four or twenty-five years of age, but the consensus of opinion obtained by the writer from some of the best engineering and commercial minds in this country to-day, is responsible. The results in both cases should produce young men who are as thoroughly fitted as possible to receive with the least loss of time whatever peculiar training the industries in which they may be employed shall require of them before they can become *profitable* employees.

The question which your Commission has before it is too great and serious for the writer to theorise upon, and so he has given to you only the results of personal knowledge. There are several points in our present system of education which may be mentioned and emphasised, although you may now be in possession of them.

The evening drawing schools of Philadelphia, Pa., and of Massachusetts, founded some thirty-five or forty years ago, may be justly credited with having produced more successful men and women than any several institutions in the country, in educating working people—young and old, male and female. It is safe to say that every factory and shop in those States have benefited by such employees. Nearly every State in the Union has been obliged to follow this farsighted policy by establishing similar schools, and the skill of the New England mechanic has been thoroughly recognised all over the country to the advancement and profit of all. Such a training has been the starting point in the successful lives of many of our men and women, and too much cannot be said in favour of affording such opportunities.

The introduction of kindergarten, Sloyd, and more especially the manual training methods, are believed to be great helps—all leading to the one idea, namely, that we are to be *economic producers of useful things*, and to that end must combine the so-called practical and theoretical sides of man.

Still another American educational movement should interest you, and that is the work of our thinking women in educating the children (and mothers through them) of our working people, how to live, and how best and most economically to care for the home, by means of sewing, cooking, and other schools. For example, the Household Economic Society, of which our townswoman, Mrs. Larned, is the president, is rapidly spreading its influence over the entire country, and doing a grand work, looking toward the general betterment of the workman in his home, which means a better workman—a thinking workman."

APPRENTICESHIP CONDITIONS.

APPRENTICESHIP CONDITIONS.

AMERICAN BRIDGE CO., ENGINEERING DEPARTMENT.

REGULATIONS GOVERNING THE EMPLOYMENT OF APPRENTICES.

Apprentices are received and maintained in the engineering department entirely on their merits. If they prove unsatisfactory, they are subject to dismissal.

Each apprentice agrees to work at the rates stipulated below for a period as stated :—

First year,	.	.	.	.	\$3 50 per week.
Second year,	.	.	.	.	4 50 „
Third year,	.	.	.	.	5 50 „
Fourth year,	.	.	.	.	6 50 „

If term of years as apprentice is honourably served, an allowance of fifty cents per week for each week of service as apprentice will be made in addition to the rates given above. This money thus allowed will be paid by the company at the end of his term as apprentice.

If any apprentice terminates his connection with the company before the expiration of his full term; or refuses to serve his full term as such; or if he should be dismissed from the service for cause, no allowance of any kind will be made in addition to the weekly salary given above.

To all those who honourably serve their term as apprentice, a certificate testifying to their experience and ability will be granted.

BALDWIN LOCOMOTIVE WORKS, BURNHAM, WILLIAMS & CO., PHILADELPHIA.

APPRENTICESHIP SYSTEM.

In recent years manufacturing has tended so largely toward specialisation that young men apprenticed to mechanical trades have been able in most cases only to learn single processes, and, as a result, the general mechanic has threatened to become practically extinct, to the detriment of manufacturing interests generally. In view of this fact, the Baldwin Locomotive Works have established a system of apprenticeship on a basis adapted to existing social and business conditions.

Apprentices are taken in three classes, as follows :—

Apprentices of the First Class.

The first class will include boys seventeen years of age, who have had a good common school education, and who will bind themselves by indentures (with the consent of a parent or guardian in each case) to serve for four years; to be regular at their work; to obey all orders given them by the foreman or others in authority; to recognise the supervision of the firm over their conduct out of the shop as well as in it; and to attend such night schools during the first three years of their apprenticeship as will teach them, in the first year, elementary algebra and geometry; and in the remaining two years, the rudiments of mechanical drawing.

Apprentices of the Second Class.

The second class indenture is similar to that of the first class, except that the apprentice must have had an advanced grammar school or high school training, including the mathematical courses usual in such schools.

He must bind himself to serve for three years, and to attend night schools for the study of mechanical drawing, at least two years, unless he has already sufficiently acquired the art.

Apprentices of the Third Class.

The third class indenture is in the form of an agreement made with persons twenty-one years of age or over, who are graduates of colleges, technical schools, or scientific institutions, having taken courses covering the higher mathematics and the natural sciences, and who desire to secure instruction in practical shop work.

The indentures or agreement in each place upon the firm the obligation to teach the apprentice his art thoroughly and to furnish him abundant opportunity to acquire a practical knowledge of mechanical business. The firm is also bound to retain the apprentice in service until he has completed the term provided for in the indenture or agreement, provided his services and conduct are satisfactory. In all cases the firm reserves the right to dismiss the apprentice for cause.

The rates of pay in the different classes are as follows:—

	1st year per hr.	2nd year per hr.	3rd year per hr.	4th year per hr.
Apprentices of the First Class,	5c.	7c.	9c.	11c.
Apprentices of the Second Class,	7c.	9c.	11c.	
Apprentices of the Third Class	1st 6 mos. of 1st year, 13c. per hr.			
	2nd "	"	"	16c. "
	1st 6 mos. of 2nd year,	18c.	per hr.	
	2nd "	"	20c.	"

In addition to the rates mentioned above, apprentices of the first class each receive an additional sum of \$125.00, and apprentices of the second class an additional sum of \$100.00, at the expiration of their full term of apprenticeship respectively

By the course of training provided for in this system it is believed that a great benefit will accrue to the mechanic as well as to the employer. To young men who have received a thorough technical education, the two years' course in shop work is especially recommended.

THE BALTIMORE AND OHIO RAILROAD CO.

RULES AND REGULATIONS GOVERNING THE EMPLOYMENT, DUTIES AND COMPENSATION OF APPRENTICES.

First Class Apprentices.

Applications for employment as first-class apprentices will be considered from boys who have had a good common school education, and are not over seventeen years and three months of age. The compensation will be as follows:—

For the first year,	8 cents per hour.
Second year,	9 " " "
Third year,	10 " " "
Fourth year,	11 " " "

Second Class Apprentices.

Applications for employment as second class apprentices will be considered from boys who have received high school training, and are not over nineteen years of age. The compensation will be as follows:—

For the First year,	9 cents per hour.
Second year,	10 " " "
Third year,	11 " " "

Third Class Apprentices.

Applications for a special course of instructions covering at least a period of two years, will be considered from young men between the ages of twenty and twenty-four years, who have a college or technical school education. The compensation for this class is as follows:—

For the First six months, . . .	14 cents per hour.
Second six months, . . .	16 " " "
Third six months, . . .	18 " " "
Fourth six months, . . .	20 " " "

During the period of apprenticeship, an apprentice shall be subject to all orders which shall be given him by the Baltimore & Ohio Railroad Co., or its agents, in and about said employment, and he shall do everything in his power to promote the interests of his employers in and about said employment.

In accepting employment the apprentice covenants and promises that he will well and faithfully serve the Baltimore & Ohio Railroad Co. during said apprenticeship, that he will obey every lawful command, that he will do no damage to his employer, nor suffer any to be done by others, that he will not waste the goods of the company, that he will not absent himself from service without permission, that in all things and at all times he will behave himself as a good and faithful employee, that he will not be guilty of vicious or immoral conduct, and that he will at all times be zealous in the performance of his duties.

An apprentice of the first class agrees that he will faithfully attend, at least two evenings of each week, during the first two years of his apprenticeship, night schools which shall teach him elementary algebra and geometry, and during the remaining two years shall teach him the rudiments of mechanical drawings.

An apprentice of the second class agrees that he will faithfully attend, at least two evenings in each week, during the first two years of his apprenticeship, night schools which shall teach him the rudiments of mechanical drawing and higher mathematics.

The Baltimore & Ohio Railroad Co. agrees to teach and instruct, or cause to be taught or instructed, said apprentice during such time as he shall remain such, the art and trade which he may select.

The apprentice shall be subject to be moved or changed from place to place and employment to employment in the shop, at such periods as may be deemed advisable. If an apprentice shall prove incompetent in such art or trade, or shall be guilty of vicious or immoral conduct, or disobedience, or neglect of duty, or by reason of physical ailments, or long continued sickness, or for any other good or sufficient reason, the Baltimore & Ohio Railroad Co. may discharge him from their employ, and terminate the apprenticeship. It is agreed that said dismissal for any of the causes aforesaid, shall be final and conclusive.

The period of labour is ten hours per day. If, however, the Baltimore & Ohio Railroad Co. shall consider their business requires the said apprentice to work for more than ten hours the day, then, and in such case, he shall work such further time as he shall be required by the company, who shall pay him for such additional service at the same rate per hour as for his usual day's work, and should the number of hours of day's work by the employees, other than apprentices, in the shops of the Baltimore & Ohio Railroad Co. be reduced to less than ten, then, in that event, the number of hours constituting a day's work to be performed by said apprentice, and the compensation may be correspondingly reduced.

No apprentice shall receive payment for such days as he shall not work. All lost time must be made up before passing into the succeeding year.

THE BROWN & SHARPE MANUFACTURING CO., MANUFACTURERS OF FINE MACHINERY, MACHINE TOOLS, &c., PROVIDENCE, R. I.

TERMS OF APPRENTICESHIP.

Applicants for admission to apprenticeship must be not less than sixteen nor more than eighteen years of age. They must be physically sound, of good moral character, and have received an education equivalent at least to that required for graduation from the public grammar schools of the City of Providence.

Application must be made in person ; and if accepted, the applicant's name will be registered and due notice given when he will be required to commence work.

The first four hundred and eighty hours of service shall constitute a term of trial. If the apprentice shall, during this term, prove satisfactory, and shall before the expiration thereof, execute, together with his father or guardian—or if he have no father or guardian, then with some other responsible party—an agreement in the form hereto annexed, then his apprenticeship shall continue for the full term, unless sooner terminated as hereinafter stated.

Apprentices will be required to serve for the term of four years—each year to consist of two thousand nine hundred and fifty working hours, which with the usual working day of ten hours each, is equal to two hundred and ninety-five working days. The remaining working days in each year will be allowed apprentices for recreation, at such time or times as the company shall direct.

Graduates of the Providence Manual Training High School, well recommended by the Principal, may have their term of apprenticeship shortened at the discretion of the company.

Apprentices will be required to perform their duties with punctuality, diligence and fidelity, and to conform to the rules and regulations which are or may be adopted for the government of the shops.

Apprentices are not allowed to use tobacco in the shops during working hours.

Apprentices shall make up lost time at the expiration of each year, at the rate of wages paid during said year ; and no year of service shall commence until the apprentice shall have fully made up all time lost in the preceding year.

The company reserves the right, whenever the state of business demands it, to shorten the hours of labour, or whenever for any reason it shall stop the works, to suspend apprentices wholly or in part ; and the making up of time so lost shall be at the discretion of the company.

The company also reserves the right, in its sole discretion, to terminate its agreement with any apprentice, also to discharge him from its employment for non-conformity with its rules and regulations, want of industry or capacity, indifference to his duties or improper conduct within or without the shops.

Apprentices will be paid for each hour of actual service (not including time allowed for recreation or time when work is suspended) the following wages :—For the first year, six cents ; for the second year, eight cents ; for the third year, ten cents ; and for the fourth year, fourteen cents. If the company shall terminate the apprenticeship during the time of trial, it will pay at the rate of six cents per hour for the time worked.

Wages will be paid on the regular pay-days of the company, as they may be established from time to time.

The company will faithfully instruct the apprentice in the machinist's art and trade, in their shops, during the term of apprenticeship.

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, PITTSBURG, PENN'A.

APPRENTICESHIP SYSTEM.

Intelligent young men, desiring to learn the machinist trade, will be admitted to this company's apprenticeship course after January 1st, 1896.

All proper and reasonable means will be afforded to have these apprentices become thoroughly instructed in all branches of the machinist trade, and, in special cases, in such other lines of work as are connected with electrical manufacturing.

Young men above seventeen years of age will be admitted to this course under the following conditions:—

Duration of Apprenticeship Course.

Applicant shall serve as apprentice for four years (or 10,960 actual working hours), if entering under twenty-one years of age; or if older at the time of entering, three years (or 8,220 actual working hours).

Compensation.

Apprentices entering the service under the age of twenty-one years will be paid for the work during the entire term, as follows:—

For the first three months (685 hours), 5 cents per hour, and for the balance of first year (2,055 hours), 8 cents per hour.

For the second 2,740 hours of labour (second year), 10 cents per hour.

For the third 2,740 hours of labour (third year), 12 cents per hour.

For the fourth 2,740 hours of labour (fourth year), 15 cents per hour.

Apprentices entering the service at the age of twenty-one years, or over, will be paid for work during the entire term, as follows:—

For the first three months (685 hours), 5 cents per hour, and for the balance of first year (2,055 hours), 10 cents per hour.

For the second 2,740 hours of labour (second year), 12 cents per hour.

For the third 2,740 hours of labour (third year), 15 cents per hour.

For each hour of actual labour performed in excess of the regular working hours of factory, apprentices will be paid at the rate of time and one-half, and such extra hours so worked will be credited upon the total number of hours to be worked as above stated.

Agreement.

At the expiration of the first 685 hours of service, each apprentice shall (in connection with father, mother, guardian, or next friend, if under the age of twenty-one years) execute with the company a regular form of apprenticeship agreement covering the entire time of service.

Each applicant upon entering the service distinctly releases the company from all liability for any injury which may be sustained by him during the entire term.

Technical Instruction and Advancement.

Apprentices who distinguish themselves by brightness and special interest in the work will be placed in the drawing office or testing department for a period of at least six months. The company will make selections from such apprentices for positions in engineering, drawing, and testing departments.

Gratuity.

This company will pay a gratuity of \$100.00 to each apprentice who successfully serves the entire term.

Rules.

Apprentices shall be subject to all shop rules, and must not be absent unless sick or excused by their superior.

Record of Work.

Each apprentice shall fill out a weekly blank, describing work performed by him during week, and forward same every Saturday to superintendent, properly endorsed by foreman.

Discharge.

This company reserves the right to discharge an apprentice at any time of his term for misbehaviour or unfaithfulness.

During the first 685 hours, apprentices will be considered on trial, and may be discharged during this time if the company is convinced that apprentice is not qualified for the trade.

Application.

Application must be made by letter written by applicant, stating fully school education and any other training, date of birth, name and address of father, or, if dead, of the mother, and if both parents be dead and the applicant not of age, name and address of guardian.

WESTINGHOUSE ELECTRIC AND MANUFACTURING
COMPANY, PITTSBURG, PENN'A.

ENGINEERING APPRENTICESHIP SYSTEM.

Course for Engineering Apprentices.

This course has been arranged for graduates of universities and technical schools.

The company desires to train a skilled force of engineers, upon whom it can draw for assistance in the various branches of its industry.

Approved applicants will be given the opportunity of entering the works of the Westinghouse Electric and Manufacturing Company, in order that they may become familiar with the various manufacturing operations, and the general construction and working of the apparatus produced. The engineering apprentices will be afforded, in the various departments of the works, actual shop and engineering experience, both mechanical and electrical, and the work of the technical school will be supplemented by the practical training thus afforded. Upon the completion of the course it is expected that the engineering apprentice will have prepared himself for filling satisfactorily a position in some department of the company's service. Preference in compensation and position will be given to those who prove their worth by aptitude and diligent attention to duty during the apprenticeship period, and by an intelligent appreciation of the work.

Duration of Course.

Engineering apprentices will be expected to remain two years on the work thus outlined, or a total period of 5,616 hours. The regular working period is 54 hours per week.

Compensation.

The engineering apprentice will be paid 16 cents per hour during the first 2,808 hours, and 18 cents per hour for the second 2,808 hours. Where called upon to work overtime or holidays, due credit will be given therefor, and the rate will be one and one-half time for such overtime work.

Agreement.

At the expiration of the first three months of service the engineering apprentice shall execute with the company a regular form of agreement covering the entire term of the course.

Each applicant upon entering the course distinctly releases the company from all liability for any injury which may be sustained by him during the entire term thereof.

Rules.

Engineering apprentices will be expected to faithfully observe all shop rules, and must not be absent from work unless sick or excused by the head of the department or section in which he may be employed.

Discharge.

The company reserves the right to discharge an engineering apprentice at any time for misbehaviour, inattention to duty, or if, in the opinion of the company, he is not qualified to pursue successfully the work undertaken.

Application.

Application for admittance as engineering apprentices must be made by letter in the handwriting of the applicant, stating:—

Date of birth.

School education, and where received.

Name of University.

Course pursued.

Degrees received.

Reference to professors or others.

Statement of any practical experience which applicant may have had.

Name and address of father, or of mother, if father is deceased, or guardian in case both parents are deceased.

TEACHERS' RETIREMENT FUND.

TEACHERS' RETIREMENT FUND.

FOR THE INFORMATION OF THOSE INTERESTED
IN THE ESTABLISHMENT OF A SCHOOL-
TEACHERS' RETIREMENT FUND, THE FOL-
LOWING FACTS ARE SUBMITTED :

Legislation to date seems to be as follows :—Special laws have been enacted by the New York Legislature for the cities of New York, Brooklyn, and Buffalo.

The Ohio and Missouri laws apply to cities of certain classes, under which Cincinnati, Toledo and St. Louis have organised. The New Jersey and California laws apply to the State; the former provides for central and the latter for local administration. A Bill for Providence is now pending in Rhode Island. New Jersey, Chicago, Brooklyn, St. Louis, Buffalo, and Cincinnati create retirement funds by a reduction of one per cent. from salaries, to which Detroit adds the amount received from fines, deductions for absence, &c. Detroit is empowered to make appropriations to aid the fund. In New York City, 5 per cent. of the Excise Tax goes to the Teachers' Retirement Fund of that city, which is otherwise made up by moneys deducted from teachers' salaries on account of absence from duty, though unavoidably detained by sickness or any other cause. Such deductions amount annually to \$60,000.

The law is elective in New Jersey, is compulsory in Chicago, Cincinnati, Toledo, Buffalo and Detroit, and elective in New York City and Brooklyn for old teachers, and obligatory on new appointees.

Mental or physical disability combined with veteran service is a condition. In New Jersey, Cincinnati and Toledo (twenty years); New York City (females, thirty years, males thirty-five); Buffalo and St. Louis (females, twenty-five years, males thirty); veteran service is the sole condition in Detroit (twenty-five years); Chicago (females twenty, males twenty-five years); Brooklyn (thirty years of service, but females must be not less than fifty-five years of age, and males sixty); Buffalo teachers of thirty-five and forty years' service, and Cincinnati and Toledo teachers of thirty and thirty-five years' service, may demand retirement on annuity. The St. Louis amended law permits retirement upon disability alone, without stipulating the term of service, and Toledo allows a sick benefit of half pay for ten months to a teacher of ten years' service.

The laws generally apply to teachers, principals and superintendents, but Chicago includes all employees of the Board of Education, clerks, janitors, engineers, &c.; and St. Louis includes administrative and clerical employees. Annuities paid in the following cities are half pay, with a maximum for New York City of \$1,000; Brooklyn, \$1,200; Buffalo, Cincinnati, Toledo and Chicago, \$600; Detroit, \$400. St. Louis, sixty per cent. of salary, maximum, \$800; and New Jersey, half pay, minimum, \$250, maximum, \$600. There is generally a provision that if funds be insufficient annuities shall be reduced *pro rata*.

Administration is invariably by a board of trustees, which, in New York City, Brooklyn and Detroit is identical with the respective Boards of Education. The comptroller is *ex-officio* treasurer in New York City, and the State treasurer in New Jersey; while in Buffalo, Chicago, Cincinnati, Toledo and St. Louis the city treasurer is made custodian of the respective funds.

The superintendent of schools is invariably a member of the board, and everywhere, except in New York City and Brooklyn, it includes representative teachers.

New York in 1897 passed bills empowering the cities of Rochester and Syracuse to create funds. The former was compulsory; deducted two per cent. from salaries; required thirty years' service; maximum annuity, \$600; minimum, \$300. It provides a \$200 disability benefit to a teacher ten years in service; also a mortuary allowance of \$100.

The Bill was endorsed by the Mayor of Rochester, but failed by one vote in the City Council.

That of Syracuse, also compulsory, contained a clause permitting teachers leaving Syracuse to teach elsewhere to continue their contributions to the fund and participate in the benefits. This failed to become law on account of a technical error.

Minnesota, and Massachusetts for Boston only, have recently defeated bills granting in the former a minimum of \$250 half-pay annuities, maximum \$500 on twenty years' service, and for Boston, maximum \$600, upon and during disability after ten years' teaching.

Rochester, Newport, and Boston will try again this year, while New York State, Minnesota and West Virginia are preparing bills applicable to the entire State.

Syracuse will pay no benefits till 1901. Providence will pay no benefits till 1902. Cincinnati will pay no benefits till 1899.

The expenses of administration are merely nominal, and in New York City, Brooklyn, Chicago, California, Providence, Syracuse, and Detroit, there is no charge to the respective funds; Cincinnati pays a secretary an annual salary of \$100, and the city treasurer has \$10 annually to make his bond good. In San Francisco, I believe, the Fund pays a secretary's salary of \$300.

Last winter laws were passed by Rhode Island and New York empowering the cities of Providence and Syracuse, respectively, to create funds.

By an Act of Parliament which is to come into operation on April 1, 1899, every English teacher's certificate will, in future, expire by effusion on his reaching the age of sixty-five. Every teacher while in "recorded service," *i.e.*, earning money from the education department, will have £3 (\$15) a year stopped out of his wages, if a man, and £2 (\$10) a year, if a woman. On attaining the age of sixty-five he becomes entitled to such an annuity for the remainder of his life as may be fixed by tables to be prepared under this Act.

STATUS OF PUBLIC-SCHOOL TEACHERS' RETIREMENT FUNDS IN THE UNITED STATES, ESTABLISHED BY LAW AND ADMINISTERED BY
STATE OR MUNICIPAL OFFICERS, FEBRUARY, 1897.

—	Approved.	Total number of Teachers.	Present contributing Membership.	Approximate income from deductions	Minimum Annuity.	Maximum Annuity.	Number of Teachers retired at first	Present number of Annuities.	Average Annuity Paid.	Average years of service of retired Teachers.	Incapacity a condition.	Minimum service required.	Age Specified.	Joining Elective.	Joining Compulsory.	Amount of permanent Fund.
Brooklyn.	May 13, 1895.	2,929	2,193	\$18,869.34	Half pay	\$1,200.00	7	21	\$519.00	Over 30	No	30 years.	Males 60 yrs. Fem. 55 yrs.	Yes for old teachers.	Yes on new appointees	\$23,218.33
Detroit.	May 22, 1895.	740	730	5,421.81	Half pay	400.00	3	16	292.75	31	No	25 years.	No.	No.	Yes.	None.
Chicago.	May 31, 1895.	4,900	5,200	45,000.00	Half pay	600.00	35	36	400.00	35	No	Fem. 20 years, Males 25 years.	No.	No.	Yes.	57,000.00
New York City	June 4, 1895.	5,033	5,033	60,000.00	Half pay	1,000.00	16	92	600.00	Over 30	Yes	Fem. 30 years, Males 35 years.	No.	Yes for old teachers.	Yes on new appointees	98,000.00
San Francisco.	Mch. 26, 1895.	950	461	Sept., 1896 5,067.34	540.00	600.00	9	8	540.00	30	Yes	20 years.	No.	Yes.	No.	None.
St. Louis.	Mch. 18, 1895.	1,576	590	3,232.75	{ 60 p. c. of salary.	800.00	Not	yet	in operation.	Yes	Yes	Fem. 25 years, Males 30 years.	No.	Yes.	No.	None.
New Jersey.	Mch. 11, 1896.	5,384	2,510	13,000.00	250.00	600.00	15	—	280.00	35	Yes	20 years.	No.	Yes.	No.	9,000.00
Buffalo.	April, 1896.	1,100	1,100	7,000.00	Half pay	600.00	10	8	300.00	34	Yes	Fem. 25 years, Males 30 years, Fem. 30 years, Males 35 years.	No.	No.	Yes.	6,733.80
Cincinnati.	Apr. 14, 1896.	940	940	7,700.00	Half pay	600.00	{ No annuities paid till 1899.		{		No	Fem. 30 years, Males 35 years.	No.	No.	Yes.	—
Toledo.	—	—	—	—	Half pay	600.00	{		{		Yes	20 years.	No.	No.	Yes.	—
Syracuse.	{ Established last year. Not yet in full operation.		—	—	—	—	{		{		No	Fem. 30 years, Males 35 years.	No.	No.	Yes.	—
Providence.			—	—	—	—	{		{		Yes	20 years.	No.	No.	Yes.	—

STATE EXAMINATION FOR TEACHERS.

STATE EXAMINATION AND CERTIFICATION OF TEACHERS.

STATE BOARD OF EDUCATION, BOSTON.

On Friday and Saturday, Sept. 25 and 26, 1903, there will be held under the direction of the State Board of Education an examination of candidates for an *elementary teachers' probationary certificate*. The examination, beginning at 9 o'clock a.m. on Friday, will be given in the following places:—Public School Class Room, Normal Art School Building, Boston; Room No. 18, Normal School Building, Worcester; Room No. 88, Normal School Building, Westfield.

The examination will be oral and written, and will be open to all who desire to take it. It must, however, be understood that the standards already set by the State in the two years' normal school course and by many cities and towns of the State in the selection of teachers will be maintained in this examination, and that, therefore, those only should take it whose scholarship and professional training or experience are of a high order.

WRITTEN EXAMINATION.

The written examination will embrace tests on the following groups of subjects:—

I.—*Languages.*

(a.) *English.*—The examination in English will test (1) the candidate's ability to write good English and his knowledge of the essentials of English grammar and rhetoric, and (2) his knowledge of the best literature of English and American authors.

The features of composition writing looked for will be those which are most encouraged in our best high schools. In place of a portion of this test the candidate may present an exercise book, *properly certified by his instructor*, containing original work of any kind.

In the literature paper, a number of optional subjects will be presented from the best known English and American classics. Those, therefore, whose reading of the best literature has been wide and appreciative have made all the preparation for this test that is needful.

(b.) *Latin or French.*—Any other foreign language may be substituted for Latin or French if due notice is given by the candidate.

1. *Latin.*—The translation at sight of simple Latin prose and verse into simple and idiomatic English. Also an examination on a portion of the first four speeches of Cicero against Catiline, directed to testing the candidate's mastery of the

ordinary forms, constructions and idioms of the language—the test to consist in part of writing simple Latin prose involving the use of such words, constructions and idioms only as occur in the speeches prescribed.

2. *French*.—The translation into simple and idiomatic English of ordinary nineteenth century prose, with direct questions testing proficiency in grammar. Also translation into French of simple English sentences or of easy connected prose to test the candidate's familiarity with simple idioms and grammatical forms.

II.—*Mathematics*.

A choice is offered of algebra or geometry.

(a.) In algebra the topics covered will include factoring, fractions, ratio and proportion, involution and evolution, arithmetical and geometrical progression, the ordinary methods of elimination and the solution of both numerical and literal equations of the first and second degrees with one or more unknown quantities and of problems leading to such equations.

(b.) The requirement in geometry will embrace the following topics :—the general properties of plane rectilinear figures; the theory of limits; the circle and the measure of angles; similar polygons; areas; regular polygons and the measure of the circle; the relations of planes and lines in space; the propositions required under these several heads are those which are contained in the ordinary text-books of plane geometry. The candidate's preparatory study should include independent solutions and demonstrations.

III.—*History*.

Candidates will be examined upon the history and civil government of Massachusetts and the United States, and so much of English history as is directly contributory to a knowledge of United States history. The examination will call for comparison of historical characters, periods and events, and, in general, for the exercise of judgment as well as of memory.

IV.—*Science*.

The examination in science will include :—

(a.) Physiology and hygiene, and (b.) any one of the following :—physics, chemistry, botany, physical geography, zoology, geology, and astronomy.

These papers will test the candidate's knowledge of such elementary facts and principles as are usually taught in good high schools.

A teacher's statement certifying to the extent and character of laboratory work done by the candidate will be accepted as partial evidence of attainments in the science with which it deals.

V.—*Drawing.*

The examination in drawing, mechanical and freehand, will test the candidate's ability to draw simple objects, with plan and elevation to scale, and to make freehand sketches of the same in perspective. The paper will also include a test in any one of the three following topics:—form, colour, and arrangement.

VI.—*Principles of Education.*

The subjects of this group will include (a.) the aims and means of education, (b.) the elements of psychology, (c.) methods of teaching the specific subjects of an elementary course, including physical culture and the rudiments of music, and (d.) school management.

If the candidate aims to teach in the kindergarten, the following group of subjects will be substituted for the above group:—

(a.) The aims and means of education, (b.) the elements of psychology, and (c.) Fröbel's views on child training; also (d.) singing, and (e.) games, songs, gifts, occupations, and, in general, the subjects and methods appropriate to kindergarten work.

ORAL EXAMINATION.

Each candidate will be questioned orally upon some of the foregoing subjects, or upon subjects which he is likely to teach, with special reference to his qualifications as a teacher.

This examination will be largely of an individual character and will be given at any time convenient to the examiners. Due allowance will be made for time taken for this purpose from the periods allotted for written tests. If the number of candidates is so great as not to give sufficient time for the oral examination of all during the two days assigned, another day may have to be given to it by those who can most conveniently reach the place of examination.

TESTIMONIALS.

Candidates must at the time of registration present certificates of a good moral character and of good physical health. The health certificate should be from a physician.

As evidence of scholarship and professional ability, papers may be presented to the examiners certifying to the candidate's graduation from any institution of learning or to the time and character of experience in teaching. Printed essays, exercise books, and any other evidence of original work may also be presented at the time of the oral examination.

CERTIFICATES.

Those who satisfactorily pass the examinations will receive a certificate of qualification to teach in the elementary schools, it being understood that the acceptance of such certificates by

towns and cities is optional. The certificate will be valid for three years from its date unless revoked earlier for cause. At the expiration of such period it may be once renewed for three years upon satisfactory evidence that the holder continues to do acceptable work as a teacher. After three years of successful experience, the holder of a probationary certificate may be a candidate for a permanent certificate. The present plan of certification contemplates the giving of both probationary and permanent certificates for teachers of elementary and secondary schools, and also for teachers of special subjects.

A register of approved teachers will be kept at the office of the secretary for the inspection of school officials. Copies of testimonials and other evidence of professional qualification may at any time be sent to be filed with the candidate's other papers.

PRELIMINARY AND CREDITED TESTS.

Candidates who pass satisfactorily the oral test and four of the written tests may be examined in the other four subjects at a subsequent time within a period of two years.

NOTICE OF REGISTRATION.

That proper arrangements may be made, it is desired that all who think of taking the September examination shall send their names and addresses to John T. Prince, in the care of the secretary's office, before the first of September, 1903.

JOHN T. PRINCE,

Agent of the Board

for the Certification of Teachers.

